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Review of Biologically Significant Caves and their Faunas in Florida and South Georgia

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ABSTRACT—At least 267 biologically significant caves have been identified in Florida and south Georgia. Alachua, Jackson, Marion, and Suwannee counties, Florida, contain over half of these localities. The macroscopic troglobitic faunas in these caves include 27 invertebrates and one vertebrate. The terrestrial component consists of an insect and a spider; the rest are aquatic. One branchiobdellid annelid and three entocytherid ostracod crustaceans are obligate symbionts on troglobitic crayfishes and probably should be considered troglobites. The rest of the region's reported cave fauna is composed of 23 troglophiles, 47 trogloxenes, and 37 accidentals. At least one bat (*Myotis grisescens*) is regularly dependent on Florida caves for certain parts of its life cycle, but leaves the cave environment to feed and migrate. Two other cave-dependent bats (*Myotis keeni* and *Myotis sodalis*) have been recorded only rarely from the region. Two bats routinely use Florida caves, but also roost in other habitats. The region's obligate cave species are grouped into six cave faunas: Econfina Creek, Apalachicola, Woodville, Ocala, St. Johns River, and Miami. Each fauna is restricted to a particular karst region and is characterized by precinctive taxa. The Ocala Fauna has the largest number of taxa (12) and inhabits the largest geographic area, whereas the Econfina Creek Fauna has the smallest number (2). The latter also is the only fauna in the region that does not include at least one troglobitic crayfish and amphipod. The two most complex faunas (Ocala and St. Johns River) are subdivided into smaller assemblages. Most Florida troglobitic taxa have been identified by the Florida Committee on Rare and Endangered Plants and Animals as

deserving state and/or federal protection; currently one cave crayfish is considered a Species of Special Concern by the State of Florida; and the Squirrel Chimney Cave Shrimp is listed as Threatened under provisions of the U. S. Endangered Species Act of 1973, as amended.

Since 1894, naturalists have identified Florida springs, sinkholes, and caves as habitats of plants and animals (Hubbard 1901; Lonnberg 1894, 1895; Faxon 1898; Hubbell 1936; Carr 1939; Hobbs 1940*a*, 1941, 1942*a*, 1942*b*; Young 1942, etc.). H. H. Hobbs, Jr. and H. B. Sherman apparently were the first to attempt a systematic survey of Florida's caves in order to enhance their studies of cave species (Hobbs 1942*b*; Hobbs et al. 1977). Ferguson et al. (1947) followed with the first catalogue of the springs of Florida, a work that was later updated by Rosenau et al. (1977). In 1962, the Florida Speleological Society published the first extensive inventory of caves of Florida and south Georgia (Hippenmeier et al. 1962). This list included 188 caves in Florida and south Georgia that could be entered using traditional caving methods. The pioneering survey efforts of the Florida Speleological Society also led to papers on the state's cave-associated vertebrates (Pylka 1957) and aquatic troglobites (Pylka and Warren 1958, Warren 1961). The crayfish portion of Warren's 1961 list was updated by Hobbs et al. (1977), Franz (1982), Franz and Lee (1982), Hobbs (1989), and Franz and Franz (1990). Peck (1970) provided the first comprehensive list of terrestrial arthropods from Florida, including the first records of terrestrial troglobites from the state. Franz et al. (1971) presented a list of gastropods from caves in the Marianna area of west Florida.

Since 1968, many important biological discoveries in Florida caves have led to the description of 11 new troglobitic taxa. Most of these discoveries resulted directly from efforts of the cave diving community, particularly divers associated with the Cave Diving Section of the National Speleological Society and National Association of Cave Divers. Aided by advances in SCUBA equipment, divers penetrated many previously inaccessible underwater cave systems. These discoveries have enhanced our ability to interpret better the factors that have led to the development of the region's complex aquatic troglobitic faunas.

This paper provides an updated list of the troglobitic species of Florida and south Georgia. It summarizes distributional records for both troglobitic and other cave-inhabiting species and comments on the zoogeographic patterns exhibited by troglobitic species in the region. The distributional patterns for cave crayfishes originally proposed by Franz and Lee (1982) for the most part remain intact, i.e., (1)

faunas of the Apalachicola, Woodville, Ocala, and St. Johns River karst areas are found in groundwater habitats associated with the Floridan aquifer, primarily the upper Eocene Ocala Group limestones; (2) limestones covered with deep sand and clay overburdens tend to lack troglobites; and (3) the distribution of certain troglobites are correlated with the relative levels of organic materials that collect in subterranean systems.

METHODS

We obtained information on caves and their faunas from many sources. Over the years, dozens of cavers and cave divers provided critical specimens of cave species and freely contributed information on cave locations, maps, and descriptions, which have given us a better appreciation of this region's complex cave faunas.

Precise locations of caves have been omitted from our paper given the sensitivity of caves and their faunas to human disturbance. If someone needs specific information concerning particular sites they should contact the authors, members of the Florida Speleological Society, Cave Diving Section of the National Speleological Society, National Association of Cave Divers, or the staff of the Florida Natural Areas Inventory (FNAI) (1018 Thomasville Road, Tallahassee, FL 32303).

We obtained voucher specimens from previously unsampled caves in a variety of ways. Many samples were either caught by hand or with dip nets. When possible, cave crayfishes were caught in minnow traps that were baited with canned cat food. Cans were punctured and placed inside the closed traps. This technique proved very successful, e.g., two traps left for 24 hours in the main pool at Sunday Sink (Marion County) attracted 125 crayfish (*Procambarus lucifugus*); however, this technique was not effective in catching spider cave crayfishes (*Troglocambarus*) in more than a hundred trapping attempts.

Terms—Common names for decapods follow Williams et al. (1989), except when new distributional information or taxonomic interpretations beg for the use of another name. We also propose common names for recently described taxa that were not included in Williams et al. (1989). Additional common names have been applied over the years to a number of the taxa and are listed in the *Other Common Names* section of appropriate species accounts.

We use an ecological classification for cavernicoles modified from Peck (1970), Hobbs III (1992), and Holsinger (personal communication, Old Dominion University). *Troglobites* (or stygobionts) are restricted to caves or groundwater habitats and have obvious morphological adaptations for subterranean habitats (e.g., reductions of the eye structure

and loss of pigmentation); *troglophiles* may complete their life cycles in caves, as well as in certain non-cave habitats, and do not show the extreme morphological adaptations that are usually reserved for troglobites; *trogloxenes* regularly are encountered in caves but can not complete their life cycles in them; *accidentals* are species that do not normally inhabit caves but for one reason or another had taken refuge in specific caves at the time of visitation.

We follow Frank and McCoy (1989) in their uses of the terms indigenous and precinctive, rather than native and endemic. Based on their interpretations, "indigenous" is preferred to "native" because the latter has "subsidiary meanings in English;" "precinctive" is restricted to taxa that are indigenous and "known from no other area."

HISTORY OF FLORIDA BIOSPELEOLOGY

Early Period (1893-1897)—Florida biospeleology began in 1893 with the discovery of white crayfishes in a hand-dug well at Lake Brantley, near Orlando, Seminole County. This crustacean was named *Cambarus acherontis* by its collector, the Swedish naturalist Einar Lonnberg (Lonnberg 1894, 1895).

The next discoveries occurred in 1894 while H. G. Hubbard, the noted entomologist who worked as a Special Agent of the U.S. Entomological Commission (United States Department of Agriculture), was visiting colleagues, W. T. Webber and H. J. Swingle at Eustis, Florida. According to Hubbard (1901:395-396), after receiving word of caves in Hernando and Citrus counties, they traveled the 30 or 40 miles (48-64 km) from Eustis to explore caves at "Istachatta on the Withlacoochie River" and "Double Hammock country, in Citrus County." At Double Hammock, they encountered a large "cavern, 75 to 100 feet deep, in a hillside of open pine woods." They noted "white crawfish very much like those in the Mammoth Cave," bats, streblid flies (*Trichobius major*), mites, "hairy Muscid" (fly), minute black gnats, spiders, "Hemipteron," molds, and cave fungi. They named this cave Gum Tree Cavern (later called Gum Cave or Sweet Gum Cave) because of a large sweet gum tree that grew on the verge of the sinkhole entrance. Their collection of white crayfishes from this cave currently resides in the crustacean collection at the U.S. National Museum of Natural History. Faxon (1898) examined these specimens, but failed to recognize their uniqueness. He assigned them to Lonnberg's *Cambarus acherontis*, an interpretation that was followed by Harris (1903) and Ortmann (1902, 1905). The Gum Tree Cavern specimens were eventually described as *Cambarus* (=*Procambarus*) *lucifugus lucifugus* by Horton H. Hobbs, Jr. (1940*a*). In addition, there was a single specimen of *Troglocambarus*

maclanei in the original Gum Tree Cavern collection that escaped the attention of Faxon and other workers and remained unnoticed until Martha R. Cooper rediscovered the specimen mixed with the others over 80 years later! Webber and Swingle also provided additional specimens of white crayfishes to the U.S. National Museum of Natural History, but there is some question as to their origins. The collection data stated only that they were received from Swingle and Webber from Eustis, Lake County, Florida, in November 1897. It is not known whether the specimens originated in the Eustis area or were collected elsewhere and shipped from Eustis. Hobbs (1940*a*) considered these specimens similar to his *Cambarus lucifugus* from Gum Cave but indicated that they possessed certain unique features. This led him to suggest that they probably represented an unidentified subspecies of *lucifugus*. As far as we are aware, there have been no further collections of this unique crayfish.

Hobbs Period (1935-1946)—Little happened in Florida speleology between 1897 and 1935. In 1931, Horton H. Hobbs, Jr. began his long and productive scientific career as an undergraduate student at the University of Florida (Hobbs 1986). Upon graduation in 1935, he enrolled in the master's program at Florida where he began his studies on Florida crayfishes under the direction of Dr. J. Speed Rogers. Hobbs was encouraged first to survey the crayfishes of Alachua County for his master's degree (Hobbs 1936), before launching into his definitive survey of the state's crayfish fauna for his Ph.D., which he completed in May 1940 (Hobbs 1940*b*). As part of this scholastic program, he became one of the leaders in the natural history revolution that occurred at the University of Florida during the pre-World War II years. Hobbs was the third person to earn a Ph.D in biology from this institution, following Archie Carr and H. K. Wallace.

In March 1935, Hobbs found his first cave crayfishes (*Procambarus pallidus*) in "... a small area of subterranean water exposed in the bottom of a cavelike lime sink in the southern part of Columbia County" (=Riverbed Cave) (Hobbs 1940*a*, 1986). This site was located in an abandoned stream valley at the base of the railroad embankment along U.S. Highway 27 west of High Springs. We have searched the immediate area around the railroad embankment but were not successful in relocating an exposure of subterranean water at this site; however, we have found troglobites in other sinks north of the embankment further up the valley.

Between 1936 and 1942, Hobbs collected additional material of *Procambarus lucifugus lucifugus* at Sweet Gum Cave in Citrus County,

the site of Hubbard's original collection in 1894, with the assistance of H. B. Sherman and other colleagues. Hobbs (1940*a*) also reported a second collection of this crayfish from an unidentified cave, 23.3 km (14 miles) north of Weekiwachee Springs in Hernando County, obtained by Albert Greenburg in 1937.

The first specimens of *Procambarus lucifugus alachua* were taken in Alachua County at Hog Sink in November 1937 (Hobbs 1940*a*) and at Goat Sink in January 1938. During the following November, Hobbs visited Palm Springs in Seminole County and for the first time since the original collection by Lonnberg he obtained additional material of *Procambarus acherontis* in the spring pool (Hobbs 1942*b*, 1986). Following these successes, Hobbs and Dr. Sherman used aerial photographs to locate sinkholes and other depressions, then visited the sites to determine whether they led to subterranean water. This systematic survey in the vicinity of Gainesville, Alachua County, led to the discovery of sites such as Squirrel Chimney (Hobbs et al. 1977). Between 1937-1942, students and friends, particularly William M. McLane, Lewis J. Marchand, and Alphonse C. Chable, accompanied Hobbs during his explorations. Other companions included J. Adams, W. Beck, L. Berner, A. Carr, T. Carr, J. C. Dickinson, C. S. Goodnight, M. L. Goodnight, B. J. Kaston, J. Kilby, J. M. Martin, C. Mohr, G. Pournelle, H. B. Sherman, K. Spurr, H. K. Wallace, and F. N. Young. McLane discovered the first specimens of the Northern Spider Cave Crayfish at Squirrel Chimney in March 1941, which Hobbs named *Troglocambarus maclanei* in McLane's honor (see Hobbs et al. 1977 for a discussion of this discovery).

In 1939, Archie Carr obtained the original specimen of the cave salamander, *Haideotriton wallacei*. This specimen was retrieved by Mr. Hummel, sanitary engineer with Dougherty County (Georgia), from a "200-foot well" in Albany, Georgia, after it was air-lifted to the surface (Carr 1939).The animal was named in honor of H. K. Wallace, the spider expert, Carr's colleague and friend at Florida, and Hobbs' brother-in-law. The holotype was sent alive through the mail in a Mason jar to H. K. Wallace who brought it to the attention of Archie Carr (H. K. Wallace, personal communication, [retired] University of Florida). Wallace had met Mr. Hummel when he and A. P. Black were consulting with city engineers in Albany, Georgia, in early May 1939 (H. K. Wallace, personal communication).

World War II interrupted the flow of natural history research at Florida, although several students returned after the war to finish their studies. Hobbs continued to teach at Florida until 1946 when he moved to the Biology Department at the University of Virginia. He served as the Director of the Mountain Lake Research Station between

1956-1960, and then moved on to the Department of Zoology at the U.S. National Museum of Natural History in 1962. Although retired from the Smithsonian since 1984, he retains his emeritus status there and continues to pursue his studies on the systematics of crayfishes, ostracods, and other crustaceans. Between 1940-1942, Hobbs described *Cambarus* (=*Procambarus*) *lucifugus lucifugus*, *Cambarus* (=*Procambarus*) *lucifugus alachua*, *Cambarus* (=*Procambarus*) *pallidus*, *Troglocambarus maclanei*, and *Cambarus cryptodytes* (Hobbs 1940*a*, 1941, 1942*a*). His collections of other cave organisms from Alachua County caves led to the descriptions of the isopod *Asellus* (=*Caecidotea*) *hobbsi* (Maloney 1939) and the amphipod *Crangonyx hobbsi* (Shoemaker 1941). Hobbs' early crayfish studies culminated with the publication of his treatise *Crayfishes of Florida* (Hobbs 1942*b*). This book continues to be the single most important reference on the state's crayfish fauna.

Post-Hobbs Period and the Florida Speleological Society (FSS) (1946-1969)—Little activity occurred in Florida biospeleology immediately following Hobbs' departure from the state. In 1954, Pirkle and Babb obtained a specimen of *Procambarus pallidus* from a well at Four O'Clock Church (Fort Clark) in Alachua County. Between 1952-1954, Robert B. Cumming, while an undergraduate student at the University of Florida, collected troglobitic crustaceans. His Florida cave collections included *Troglocambarus maclanei* from Squirrel Chimney and Sweet Gum caves in 1953 and 1954, respectively; *Procambarus lucifugus* and *Procambarus pallidus* from Eichelberger Cave in 1952; and the first specimen (a female) of *Palaemonetes cummingi* from Squirrel Chimney in Alachua County in 1953 (Chace 1954). The presence of *Procambarus pallidus* in Eichelberger Cave later was questioned by Franz and Lee (1982) because this locality is 40 km from the next closest documented site, and no other specimens of this crayfish have been collected from caves in the vicinity of Eichelberger Cave before or since Cumming's specimens were obtained. Eichelberger Cave has been destroyed by quarrying activities. Franz and Lee (1982) suggested that the collection had been mixed accidentally, and the *Procambarus pallidus* specimens actually were collected elsewhere. Search should be continued for the species in Marion County.

A second inventory of Florida and south Georgia caves began in 1949 with the establishment of a caving club in Gainesville. The survey was expanded to include biological and paleontological surveys when the club became a University of Florida student grotto of the National Speleological Society in 1952.

In 1956, Peter Drummond, an early member of the Florida Speleological Society, collected the first specimens of *Cambarus cryptodytes* from Climax Cave, Decatur County, Georgia, and Horst R. H. Heineman obtained specimens of what Hobbs initially identified as *Procambarus pallidus* (=*Procambarus orcinus*) at Clay Sink (probably Gopher Sink) in Leon County, Florida. Richard D. Warren was active with the Florida Speleological Society between 1956-1965. He contributed specimens of *Procambarus lucifugus* X *alachua* from Roosevelt Cave in 1960; *Procambarus erythrops* from Hildreth Cave in 1962; and *Troglocambarus maclanei* from Indian Cave in 1962. He also collected specimens of *Cambarus cryptodytes* in 1961 and 1963 at Climax Cave, the type series of *Asellus* (=*Remasellus*) *parvus* from Ten Inch Cave in 1962, and with Bousfield the type series of *Crangonyx grandimanus* from Indian Cave (Marion County) in 1962. Gerard M. Miller and Warren were the first to discover *Haideotriton wallacei* in Florida. They initially recovered specimens from Gerard's Cave in Jackson County in 1957 (Pylka and Warren 1958), and later found this salamander in Judge Cave and Washed-out Cave in Florida and at Climax Cave in Georgia (Warren 1961). Additional specimens from Climax Cave were secured by Alberta Etters (Smith) and Vernal Harkness in 1960. A brief list of cave-associated vertebrates (without specific localities) was provided by Pylka (1957). At the same time, Dale W. Rice and William L. Jennings were investigating the distribution and ecology of cave bats, particularly in the Marianna area (Jennings and Layne 1957; Jennings 1958; Rice 1955*a*, 1955*b*, 1957).

Biospeleologists John E. and Martha R. Cooper visited Richard D. Warren in 1964-1965. The Coopers obtained specimens of *Procambarus acherontis* in 1964 and 1965 at Palm Springs. The initial specimens were netted from aquatic vegetation in the spring pool; a second series was acquired from the pool by the property manager of the spring property and given to the Coopers when they returned to Palm Springs in 1965 (Cooper 1965*a*). With Warren, they also visited Goat Sink, Protheroe Sink, and Still Sink where they obtained samples of troglobitic crayfishes (Cooper 1965*b*).

Frank Hurt retrieved the first record of *Cambarus cryptodytes* from the cave at Waddell's Mill Pond in 1965. S. B. Peck made a collection of *Procambarus pallidus* at Warren Cave in 1965. This appears to be the first collection of the species from Warren Cave since Hobbs' original specimens. Notes associated with the collection indicated that the cave had been dry for 4 years prior to his finding them. Peck also obtained specimens of *Cambarus cryptodytes* at Climax Cave (Hobbs 1981) and two new staphylinid beetles at Miller's Cave

(Klimaszewski and Peck 1986). Peck's inventory of Florida caves included three collembolans, three orthopterans, six beetles, two opilionids, five spiders, one millipede, and one centipede (Peck 1970).

David S. Lee, then a student at Florida Southern College, started to visit caves in Alachua, Citrus, and Jackson counties, Florida, in 1965 (D. S. Lee, personal communication, North Carolina State Museum of Natural Science). Between 1965 and 1970, he discovered many new biologically significant sites, particularly in northwest Florida, and made several important collections, one of which was the first and only ovigerous female *Palaemonetes cummingi* from Squirrel Chimney. He conveyed this specimen alive to Sheldon Dobkin at Florida Atlantic University who successfully reared the developing larvae and published the first description of the larval development for this species (Dobkin 1971). Merlin Tuttle also visited caves in Jackson County during this same period in pursuit of gray bats (*Myotis grisescens*). Lee and Tuttle combined their expertise and encouraged the Florida Park Service to gate Old Indian Cave at Florida Caverns State Park to protect its important bat colony (Lee and Tuttle 1970), and Lee later encouraged them to limit access to other biologically sensitive caves in the Park. Lee introduced Richard Franz to Florida biospeleology in 1967. On one of the trips to Florida from Maryland, Lee and Franz visited Squirrel Chimney in hopes of obtaining additional specimens of the Squirrel Chimney Cave Shrimp, but instead, rescued a large eastern diamondback rattlesnake (*Crotalus adamanteus*) from the bottom of the vertical entry shaft (Franz 1968). Lee and Franz continued to travel to west Florida between 1968 and 1970 to explore caves in Jackson and Washington counties. Data from this period provided the basis for studies on the predatory snail *Euglandina rosea* (Franz et al. 1971) and on the cave salamander, *Haideotriton wallacei*, and other vertebrates in Jackson County caves (Lee 1969*a*, 1969*b*, 1969*c*, 1969*d*, 1976). In 1970, they collected the first specimens of *Cambarus cryptodytes* and *Haideotriton wallacei* from Pool Cave in Florida Caverns State Park. The next year, Franz took Archie Carr to this cave and showed him his first live *Haideotriton* since he had described the salamander in 1939. In 1972, Franz joined the faculty of the Florida State Museum (recent name change to Florida Museum of Natural History) at the University of Florida where he currently continues his cave studies.

Modern Period (1970-1992)—The discovery of a new troglobitic crayfish in a Miami well in 1968 rekindled interest in the state's cave crayfish fauna. This species, eventually described as *Procambarus milleri* (Hobbs 1971), was the first new cave crayfish found in Florida

since 1942 and the first new troglobite since the descriptions of *Crangonyx grandimanus* (Bousfield 1963) and *Asellus parvus* (Steeves 1964). The discovery of the Miami Cave Crayfish set the stage for the disclosure of four other crayfish discoveries in the 1970s.

D. Bruce Means, who began visiting northwest Florida caves in the mid-1960s, made numerous important collections of cave crayfishes and vertebrates from caves and sinks in the Tallahassee and Marianna areas. Means made several collections of a new crayfish at Gopher Sink and Culley's Cave in 1970 and 1971, which he and Hobbs later named *Procambarus orcinus* (Hobbs and Means 1972). Other collectors who contributed specimens used in the type description of this crayfish included H. R. H. Heineman (Clay Sink, 1956), J. Halusky (Gopher Sink, 1970), J. Bishop (Osgood Sink, 1968), J. Couch (cave 3 miles (4.8 km) south of Woodville, 1962), and L. B. Trott (Wakulla Springs, 1957). Specimens of a second new crayfish, collected first by Michael N. Horst at Big Blue Spring on the Wacissa River in Jefferson County in 1970, were described as *Procambarus horsti* in the same paper with *Procambarus orcinus* (Hobbs and Means 1972).

Barry Mansell and Frank Hurt collected the first specimens of a new cave crayfish at Sim's Sink (*Procambarus erythrops* Relyea and Sutton, 1975) in Suwannee County in 1971 (B. Mansell, personal communication, Jacksonville, Florida); they also took specimens of *Troglocambarus maclanei* from Sim's Sink, *Procambarus lucifugus* from Bat Cave (Alachua County), Sweet Gum Cave, and Indian Cave (Marion County), and *Procambarus pallidus* from Squirrel Chimney in 1971-1972. Mansell and Bruce Sutton collected specimens of *Haideotriton wallacei* from Gerard's cave in 1969. Kenneth Relyea and Sutton's explorations of north Florida caves were contemporary with those of Means, Mansell, and Hurt. They collected additional material of *Procambarus erythrops* from Sim's Sink in 1971-1972; *Procambarus pallidus* from Pallidus Sink, Squirrel Chimney, and Martin Cave in 1972; and *Troglocambarus maclanei* from Sim's Sink in 1975. The new material, plus those collected by Mansell and Hurt, from Sim's Sink allowed Relyea and Sutton to describe *Procambarus erythrops* (Relyea and Sutton 1975). Relyea also obtained two specimens of a unique crayfish from Alexander Springs in Lake County in 1973 and 1974 (Relyea et al. 1976) that later was described as *Procambarus delicatus* following the collection of a third specimen in 1985 by J. B. Smith and D. Haren II (Hobbs and Franz 1986).

In 1973, Stephen R. Humphrey and Franz visited Orange Lake Cave in Marion County for the first time after cavers reported large numbers of bats present in the cave. Lee and Franz returned to this

site in 1974-1975 and collected several series of crayfishes. They were later described as *Procambarus franzi* (Hobbs and Lee 1976). Subsequent collections at Hell Hole and Trade Wind Farm's Sink extended the known range of this species several kilometers south toward the Reddick area. Chert Cave and Sunday Sink, south of Ocala, were found to have large populations of *Procambarus lucifugus* intergrades and *Troglocambarus maclanei*. The latter was located as a result of surveys associated with the Cross-Florida Barge Canal study. Ray Ashton and Pat Sawyer Ashton collected the first specimens of *Procambarus lucifugus* intergrades from Ocala Caverns in 1976.

The momentum established in the 1970s continued into the 1980s and 1990s. Additional discoveries led to the descriptions of *Procambarus leitheuseri* in Hernando and Pasco counties (Franz and Hobbs 1983), *Procambarus delicatus* in Lake County (Hobbs and Franz 1986), *Procambarus morrisi* in Putnam County (Hobbs and Franz 1990), *Procambarus attiguus* in Marion County (Hobbs and Franz 1992), and *Dasyscias franzi* in Washington County (Thompson and Hershler 1991). During this period, there were also collections of several crustaceans that still remain unstudied (e.g., two *Caecidotea* from Orange and Washington counties and a *Troglocambarus* from Orange County). Recent collections of Steeves' *Asellus parvus* at Split Sink and Peacock Springs allowed Bowman and Sket to recognize the uniqueness of this isopod for which they erected the new genus *Remasellus* (Bowman and Sket 1985).

Throughout this period, cavers and divers continued to provide many other important specimens that added tremendously to our knowledge of the distributions of *Crangonyx grandimanus*, *C. hobbsi*, *Procambarus acherontis*, *P. horsti*, *P. lucifugus*, *P. orcinus*, *P. pallidus*, and *Troglocambarus maclanei*. Most recently, Buford Pruitt has taken many important voucher specimens of *Procambarus lucifugus*, *P. pallidus* and *Troglocambarus maclanei* in underwater caves of Levy and Hamilton counties. Pruitt also generously purchased and donated Sim's Sink to The Nature Conservancy as a cave crayfish preserve in 1987.

BIOLOGICALLY IMPORTANT CAVES

We recorded a total of 267 caves in Florida and south Georgia where biological materials have been recovered (Appendix 1). More than half are concentrated in Alachua (47 caves), Jackson (34 caves), Marion (27 caves), and Suwannee (43 caves) counties (Fig.1). Other biologically significant caves are found in Columbia (15), Levy (11), Lafayette (11), Leon (11), Hamilton (11), Gilchrist (9), Wakulla (8), Citrus (7), Hernando (6), Madison (5), Orange (4), Pasco (4), Seminole

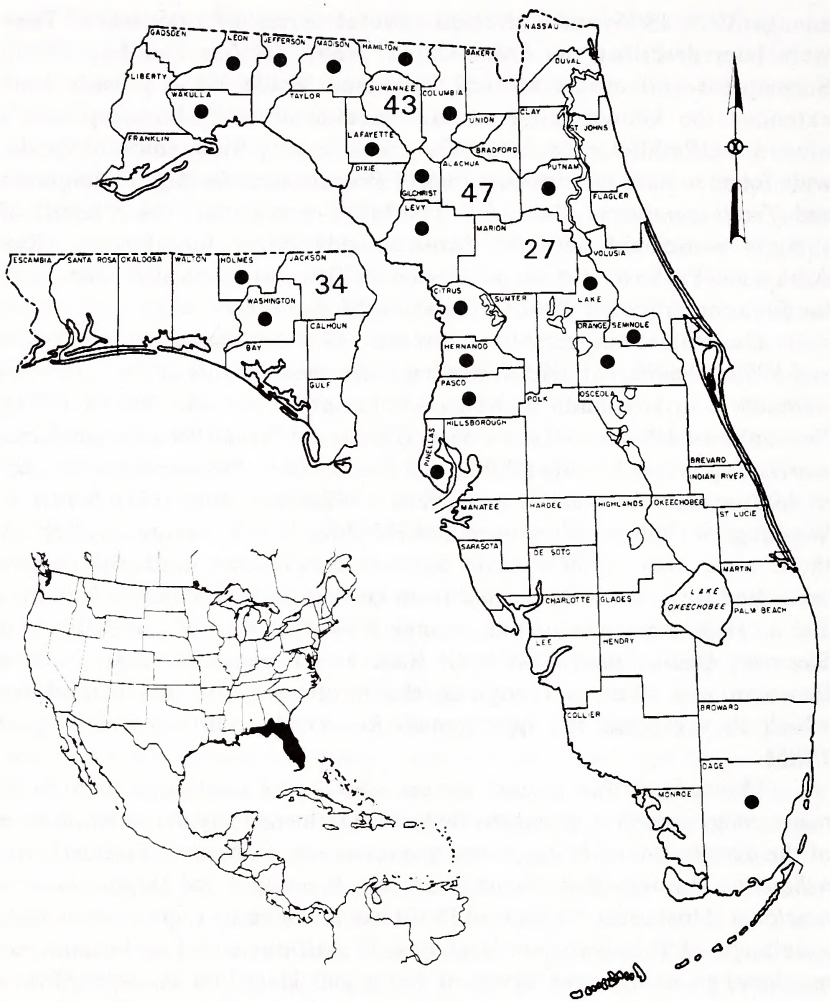

Fig. 1. Map of Florida showing county locations. Numbers of caves are shown for Alachua, Jackson, Marion, and Suwannee counties. Dots indicated other important cavernous counties.

(3), Lake (2), Washington (2), Dade (2), Holmes (1), Jefferson (1), Pinellas (1), and Putnam (1) counties, Florida, and Decatur (1) and Doughtery (1) counties, Georgia. Caves theoretically could exist anywhere in Florida and south Georgia since most of this region is underlain with extensive beds of Oligocene and Eocene limestones. These limestones are components of the Floridan aquifer, while limestones in Dade County are part of the Biscayne aquifer.

There are no reports of troglobites being recovered from especially deep wells such as those reported in the San Antonio Pool of the Edwards aquifer, Texas (blind catfishes, genera *Satan* and *Trogloglanis*, at groundwater depths between 305-582 m) (Cooper and Longley 1979*a*, 1979*b*). The deepest record of a Florida troglobite is for *Procambarus orcinus* (and possibly *Procambarus horsti*) at Wakulla Springs at about 100-m water depth. Other depth records include 67.6 m (231 ft) for *Procambarus leitheuseri* at Eagle's Nest Sink (Hernando County); 9 m (28.8 ft) for *Procambarus milleri* at the well northeast of Homestead; 44 m (150 ft) and 36.7 m (125 ft) for *Procambarus pallidus* at Fort Clark Church well and Hornsby Sink, respectively (Alachua County); 67.6 m (231 ft) for *Troglocambarus maclanei* at Eagle's Nest Sink (Hernando County); 26.4 m (80 ft) for *Cambarus cryptodytes* at Hole-in-Wall (Jackson County); and 60.8 m (200 feet) for *Haideotriton wallacei* at the Albany, Georgia, well.

Franz and Lee (1982) reasoned that limestones covered with thick layers of unconsolidated marine or aeolian sediments lack sufficient food imput to sponsor colonizing organisms. However, recent discoveries of certain colonial bacteria in a few underwater caves might provide limited grazing for troglobitic crustaceans (Hobbs and Franz 1992).

The most cavernous parts within the study region are the mature karst areas in western Alachua and Marion counties, eastern Citrus, and northcentral Jackson County, Florida. The current list maintained by the Florida Speleological Society for this four-county area includes 430 of 630 caves reported from Florida (Al Krause, personal communication, Florida Speleological Society). Caves in mature karst areas tend to have portions of their passages above the local water table. As a result many of the larger caves are inhabited by cave-dependent bats which supply large quantities of guano to fuel the biotic system. Above-water caves in the Citrus, Marion, and Jackson counties tend to be shallow and have meandering passages and multiple entrances, whereas many in Alachua County are deeper and have vertical shafts as entrances that require technical climbing equipment to negotiate. Some of the Alachua entrance holes are over 17.6 m (50 ft) deep. Speleothem development is rare in most Florida caves, although some caves in Citrus, Marion, and Jackson counties have interesting displays.

Saturated riverine karsts are developed along portions of the Choctawhatchee, (western) Econfina, Chipola, Flint (Georgia), St. Marks-Wakulla, Wacissa, Suwannee, and St. Johns rivers and their tributaries. Caves within these karsts have little or no dry passage. Access to them is usually through spring outlets, spring-siphons, or water-filled sinkholes.

Rosenau et al. (1977) listed over 300 springs in 42 Florida counties, most of which have their water sources in the Floridan aquifer, particularly the Ocala Group of Eocene limestones. Twenty-seven of these springs have recorded water flows that average six billion gal/day each and are considered first magnitude springs (Rosenau et al. 1977). Counties with saturated riverine karsts where biological specimens have been retrieved include Columbia, Dade, Gilchrist, Hamilton, Hernando, Jefferson, Lafayette, Lake, Leon, Levy, Madison, Orange, Pasco, Pinellas, Seminole, Suwannee, Wakulla, and Washington. Extensive underwater cave systems found in these counties form important conduits for local groundwater circulation. Knab (1991) noted that six of the ten longest known underwater caves in the world are located in the saturated karsts of the Suwannee and Wakulla drainage basins in Florida—Falmouth Spring (or Cathedral Sink), 3,291.8 m (10,828.3 ft); Chip's Hole, 3,169.9 m (10,427.3 ft); Sullivan's Sink-Cherry Sink, 2,590.8 m (8,522.4 ft) (Leon County, Wakulla River); Manatee Springs, 2,342.4 m (7,705.3 ft) (Levy County, Suwannee River); Luraville-Telford Spring, 2,194.5 m (7,218.7 ft) (Suwannee County, Suwannee River); Hornsby Sink, 2,055.3 m (6,760.8 ft) (Alachua County, Suwannee River). Recent explorations of the Leon Sinks complex under Leon and Wakulla counties have revealed over 14,288 m (47,000 ft) of continuous mapped passage (Gary Knecht, personal communication, Tallahassee, Florida).

SPECIES ACCOUNTS FOR FLORIDA AND SOUTH GEORGIA TROGLOBITES

Phylum MOLLUSCA

Class GASTROPODA

Order PROSOBRANCHIA

Family Hydrobiidae

Dasyscias franzi Thompson and Hershler

SHAGGY GHOSTSNAIL

Dasyscias franzi Thompson and Hershler, 1991. Malacological Review 24:57-61. TYPE LOCALITY: Blue Spring Cave System, Econfina River, Washington County, Florida. Holotype (UF 93964), 27 paratypes (UF).

DISTRIBUTION: ECONFINA CREEK FAUNA. Known only from the type locality.

ETYMOLOGY: Named for Richard Franz, discover of the snail.

REFERENCES: Thompson and Hershler 1991 (original description, SEM photograph).

Phylum ARTHROPODA
Class MALACOSTRACA
Order ISOPODA
Family Asellidae
Caecidotea hobbsi (Maloney)
HOBBS' CAVE ISOPOD

Asellus hobbsi Maloney, 1939. Proceedings of U.S. National Museum 68(3057):457. TYPE LOCALITY: Dudley Cave, Alachua County, Florida. Holotype (USNM 76434), Horton H. Hobbs, Jr. (coll.), 31 October 1937. Paratypes from Dudley Cave and from crayfish burrows at Blountstown, Calhoun County, Florida.

Caecidotea hobbsi.—Bowman, 1975:339-340.

DISTRIBUTION: APALACHICOLA (Marianna Lowlands) and OCALA FAUNAS (Upper Suwannee, Marion); also northcentral Georgia. Known from groundwater habitats in Alachua, Calhoun, Jackson and Marion counties, Florida, and in DeKalb County, Georgia. This species is not restricted to limestone areas and may be more widely-distributed than records indicate. It probably lives in interstices saturated with groundwater in unconsolidated sediments, as well as in cave pools, similar to other members of the Hobbsi group (Lewis 1982, Lewis and Holsinger 1985). The isopod was listed as a Species of Special Concern by the Florida Committee on Rare and Endangered Plants and Animals because of its restriction to groundwater habitats and its apparent rarity (Franz 1982).

SPECIFIC LOCALITIES: FLORIDA, *Alachua County*: Aulsbrook Cave (RF), Bat Cave (USNM), cave 21.7 km (13 mi) west of Gainesville (probably Dudleys Cave) (USNM), Dudley Cave-type locality (USNM, Maloney 1939, Hobbs 1942*b*), well near Micanopy (USNM). *Calhoun County*: 3.6 km (2 mi) south of Altha, near Blountstown (burrow of the Apalachicola Burrowing Crayfish, *Procambarus rogersi*) (USNM). *Jackson County*: Gerard's Cave (USNM). *Marion County*: Hollowed Ground Cave? (J. Lewis), Rainbow Acre's Cave (USNM), Roosevelt Cave (USNM). GEORGIA, *DeKalb County*: spring on Walter Chandler Estate at Emory University (USNM).

ETYMOLOGY: Named in honor of Horton H. Hobbs, Jr., the collector of the type series.

REMARKS: The Georgia record constitutes a major range extension for this species. Their identification was confirmed by T. E. Bowman (personal communication, U.S. National Museum of Natural History).

REFERENCES: Franz 1982 (conservation status), Harris 1968 (as prey); Hobbs 1942*b* (records); Lee 1969*a* (as prey); Maloney 1939

(type description), Steeves 1964 (records), 1966 (taxonomy), Warren 1961 (records, photograph).

Caecidotea sp. 1

REMARKS: Specimens of asellid isopods were collected on floating wood in the cave stream of the Econfina Blue Spring Cave System in Washington County, Florida (ECONFINA CREEK FAUNA). According to J. Lewis (personal communication, Louisville, Kentucky), this species is closely related to *Caecidotea alabamensis* and *C. nickajackensis*, which are found at cave sites in northern Alabama, and in all probability it represents an undescribed taxon. Additional collecting is necessary in order to resolve this isopod's taxonomic assignment (J. Lewis, personal communication).

Caecidotea sp. 2

REMARKS: An undescribed asellid isopod was collected by Roger Werner in Rock Springs Cave, Orange County, Florida (USNM) (ST. JOHNS RIVER FAUNA, Wekiva). Its relationships with other *Caecidotea* are unstudied (T. E. Bowman, personal communication).

Remasellus parvus (Steeves)

SWIMMING FLORIDA CAVE ISOPOD

Asellus parvus Steeves, 1964. American Midland Naturalist 71(2):450-451. TYPE LOCALITY: Ten Inch Cave, 8.4 km (5 mi) of Newberry, Alachua County, Florida. Holotype and allotype (USNM 111142), a paratypic female (USNM 111140) and paratypic male (USNM 111141), R. D. Warren (coll.), 9 June 1961.

Remasellus parvus.—Bowman and Sket, 1985:554.

DISTRIBUTION: WOODVILLE and OCALA (Upper Suwannee) FAUNAS. Known from groundwater habitats in karst areas of the Wakulla and upper Suwannee rivers. It may be more common than collections indicate.

SPECIFIC LOCALITIES: *Alachua County*: Ten Inch Cave-type locality (USNM). *Madison County*: Thunderhole Sink (USNM). *Suwannee County*: Peacock Springs Cave System (USNM). *Wakulla County*: Split Sink (USNM).

ETYMOLOGY: *Remasellus* from remus=oar (Latin) + Asellus, referring to the shape and function of pereopod 2-7 (Bowman and Sket 1985); *parvus* refers to small; so named because of its relatively small size (Steeves 1964).

REMARKS: Unlike *Caecidotea hobbsi*, this isopod may be restricted to cave habitats in light of its unusual morphology and swimming mode of locomotion.

REFERENCES: Bowman and Sket 1985 (definition of *Remasellus*, records); Steeves 1964 (original description).

Order AMPHIPODA

Family Crangonyctidae

Crangonyx grandimanus Bousfield

FLORIDA CAVE AMPHIPOD

Crangonyx grandimanus Bousfield, 1963. National Museum of Canada, Natural History Paper No. 18:1-9. TYPE LOCALITY: Indian Cave, 11.7 km (7 mi) southwest of Ocala, Marion County, Florida. Holotype (NMC 5002), R. D. Warren (coll.), 18 February 1961. Paratype (NMC 5003) from Huggin's Cave, Alachua County, R. D. Warren (coll.), December 1961.

DISTRIBUTION: WOODVILLE, OCALA (Upper Suwannee, Lower Suwannee, Marion, Gulf Coastal Lowlands) and MIAMI FAUNAS. This amphipod was listed as a Species of Special Concern by the Florida Committee on Rare and Endangered Plants and Animals (Franz 1982) because of its subterranean habits and limited distribution, and as a candidate for federal protection (Wood 1992). It appears to be widespread in groundwater habitats associated with limestone areas on the western slope of the old Northern Highlands in the Florida peninsula. This amphipod is known from the Woodville Karst in the St. Marks-Wakulla River basin, northern peninsula karsts from the Suwannee River south to Pasco County and from the Miami karst; however, it is rare at most sites. This amphipod has not been collected on the eastern slope in the St. Johns River valley.

SPECIFIC LOCALITIES: *Alachua County*: Dudley Cave (JRH), Goat Sink (JRH), Hertzog Cave (JRH), High Springs Cave (JRH), Huggins Cave (JRH), well (Archie Carr Farm) near Micanopy (JRH). *Citrus County*: Sweet Gum Cave (JRH). *Dade County*: well, Little Bird Nursery and Garden Store, Miami (JRH). *Gilchrist County*: Devil's Eye and Ear Springs (JRH). *Hernando County*: Eagle's Nest Sink (JRH). *Leon County*: Little Dismal Sink (JRH). *Levy County*: Archer Cave (JRH), well at Chiefland (JRH). *Madison County*: Madison Blue Spring (JRH). *Marion County*: Indian Cave-type locality (Bousfield 1963), well 3.6 km (2 mi) northeast of Anthony (JRH). *Pasco County*: Nexus Sink (JRH). *Suwannee County*: Cisteen Sink (JRH), Orange Grove Sink (JRH), Peacock Springs Cave System (JRH). *Wakulla County*:

Emerald Sink (JRH), McBride Slough (JRH), River Sinks (JRH), Sally Ward Spring (JRH), Shepard Blue Spring (JRH).

ETYMOLOGY: Although Bousfield (1963) did not indicate the origin of the name "grandimanus" in the original description, we presume that he was making reference to the "very large gnathopods" that characterize this species.

REMARKS: Holsinger (1972) listed this amphipod as a member of the *obliquus-richmondensis* group.

REFERENCES: Bousfield 1963 (type description); Franz 1982 (conservation status); Holsinger 1972 (records, key), 1977 (taxonomy).

Crangonyx hobbsi Shoemaker
HOBBS' CAVE AMPHIPOD

Crangonyx hobbsi Shoemaker, 1941. Charleston Museum Leaflet 16:457. TYPE LOCALITY: Huggins Cave, Alachua County, Florida. Holotypic male (USNM 79362), paratypic female (USNM 109623), Horton H. Hobbs, Jr. (coll.).

DISTRIBUTION: WOODVILLE, OCALA (Upper Suwannee, Lower Suwannee, Orange Lake, Marion, Withlacoochee, Gulf Coastal Lowlands), and MIAMI FAUNAS. This amphipod is widespread in limestone areas of the Florida peninsula, east of the Apalachicola River, and on occasions can be abundant at certain sites. Its distribution coincides with that of *Crangonyx grandimanus*. The species was listed as a Species of Special Concern by the Florida Committee on Rare and Endangered Plants and Animals (Franz 1982) because of its dependence on specialized subterranean habitats and its limited distribution; it is a candidate for federal listing (Wood 1992).

SPECIFIC LOCALITIES: *Alachua County*: Cave in riverbed at High Springs (=River Bed Cave?) (JRH), Crumbly Sink (JRH), Devils Hole (JRH), Dudleys Cave (JRH), Goat Sink (JRH, Hobbs 1942*b*), High Springs Cave (JRH), Huggins Cave-type locality (USNM, Shoemaker 1941, Bousfield 1963), Still Sink (Warren 1961, not seen by JRH)), well (Archie Carr Farm) near Micanopy (JRH). *Citrus County*: Sweet Gum Cave (JRH, Hobbs 1942*b*). *Columbia County*: Bussey's Sink (JRH), River Bed Cave (Hobbs 1942*b*, Warren 1961). *Dade County*: well, Little Bird Nursery and Garden Store (JRH). *Gilchrist County*: Devil's Eye and Ear Spring (JRH). *Hernando County*: Eagle's Nest Sink (JRH). *Leon County*: Sullivan's Tunnel (JRH). *Levy County*: Friedman's Sink (JRH), Manatee Springs (JRH), well at Chiefland (JRH). *Madison County*: Madison Blue Spring (JRH). *Marion County*: Chert Cave (JRH), Hell Hole (JRH), Indian Cave (Bousfield 1963, JRH), Orange Lake Cave (JRH), Roosevelt Cave (Warren 1961), Sunday

Sink (JRH). *Pasco County*: Nexus Sink (JRH), 38 m (125 ft) well at Lacoochee (JRH). *Suwannee County*: Challenge Sink (JRH), Cisteen Sink (JRH), Orange Grove Sink (JRH), Peacock Springs Cave System (JRH), Sim's Sink (JRH). *Wakulla County*: McBride Slough (JRH), River Sinks (JRH), Sally Ward Spring (JRH), Shepard Blue Spring (JRH).

ETYMOLOGY: Named for Horton H. Hobbs, Jr., the collector of the type series (Shoemaker 1941).

REMARKS: Holsinger (1972) placed this unique species in the monotypic *hobbsi* group.

REFERENCES: Franz 1982 (conservation status); Holsinger 1972 (records, key), 1977 (taxonomy); Shoemaker 1941 (type description); Warren 1961 (records).

Order DECAPODA

Family PALAEMONIDAE

Palaemonetes cummingi Chace

SQUIRREL CHIMNEY CAVE SHRIMP

Palaemonetes (*Palaemonetes*) *cummingi* Chace, 1954. Journal of Washington Academy of Science 44(10):319-323. TYPE LOCALITY: Squirrel Chimney, Alachua County, Florida. Holotype, female (USNM 95795), Robert B. Cumming (coll.), 11 July 1953.

Palaemonetes cummingi.—Warren, 1961:6.

OTHER COMMON NAMES: Florida Cave Shrimp.

DISTRIBUTION: OCALA FAUNA (Upper Suwannee). Known only from the type locality. This cave shrimp was proposed as Threatened by the Florida Committee on Rare and Endangered Plants and Animals (Franz 1982) and was listed as Threatened on 21 June 1990 under provisions of the U. S. Endangered Species Act of 1973, as amended (Anonymous 1990). Because it is known from only one site in a rapidly developing urban area, the shrimp is vulnerable to extinction from groundwater contamination and deterioration of the surface habitat around the Squirrel Chimney sinkhole. Divers failed to find shrimps after an extensive search in this underwater cave in October 1992 (Morris and Butt 1992).

ETYMOLOGY: Named in honor of Robert B. Cumming, the collector of the first specimen (Chace 1954).

REFERENCES: Chace 1954 (type description); Dobkin 1971 (larval development); Franz 1982 (conservation status); Hobbs et al. 1977 (description); Strenth 1976 (taxonomy).

Family CAMBARIDAE

Procambarus (*Leconticambarus*) *milleri* Hobbs

MIAMI CAVE CRAYFISH

Procambarus milleri Hobbs, 1971. Quarterly Journal of Florida Academy of Science 34(2):115. TYPE LOCALITY: well at the Little Bird Nursery and Garden Store, Miami, Dade County, Florida. Holotype (USNM 131257), Billy R. Drummond, George C. Miller, and others (colls.), 2 May 1968. Morphotype (USNM 131258), 16 paratypes.

Procambarus (*Leconticambarus*) *milleri*.—Hobbs, 1972:7 (by implication).

DISTRIBUTION: MIAMI FAUNA. Known from two localities in the Miami area. This species was recently collected at another site in the Miami area by W. F. Loftus and P. Radice. The new specimens are currently under study, and more information will become available at a future date (W. F. Loftus, personal communication, Everglades National Park). This crayfish is potentially vulnerable to extinction from groundwater pollution and salt water intrusion, because its entire range lies within a major urban area. The crayfish is listed as a Species of Special Concern by the Florida Committee on Rare and Endangered Plants and Animals (Franz 1982).

SPECIFIC LOCALITIES: *Dade County*: well at Little Bird Nursery and Garden Store-type locality (USNM), 9-m deep well northeast of Homestead (USNM).

ETYMOLOGY: Named in honor of George C. Miller who together with Billy R. Drummond forwarded the type specimens to Horton H. Hobbs, Jr. Mr. Miller was a long-time friend of Hobbs and fellow student of crayfish (Hobbs 1971).

REFERENCES: Caine 1974 (evolution); Franz 1982 (conservation status); Franz and Lee 1982 (distribution, evolution, records); Hobbs 1971 (original description); Hobbs et al. 1977 (description, records); Hobbs and Hobbs 1991 (key).

Procambarus (*Lonnbergius*) *acherontis* (Lonnberg)

ORLANDO CAVE CRAYFISH

Cambarus acherontis Lonnberg, 1895. Bihang till Koniglische Svenska Veterskaps-Akademiens Handlingar 22:6. TYPE LOCALITY: subterranean rivulet about 12.8 m (42 ft) from the surface in a hand-dug well, Lake Brantley, Seminole County, Florida. Syntypes (ZIAS 1/4412) (two Form II males), one of which is still extant (Hobbs 1989).

Cambarus (*Cambarus*) *acherontis*.—Ortmann, 1905:102.

Cambarus (*Ortmannicus*) *acherontis*.—Fowler, 1912:341 (by implication).

Procambarus acherontis.—Hobbs, 1942*a*:342 (by implication).

Procambarus (*Lonnbergius*) *acherontis*.—Hobbs, 1972:8

OTHER COMMON NAMES: Orange-Seminole Cave Crayfish. We prefer the use of the name Orlando Cave Crayfish because the entire world distribution occurs within the Orlando metropolitan area. It brings into focus the precarious conservation status of this species in one of the most rapidly expanding urban areas in Florida.

DISTRIBUTION: ST. JOHNS RIVER FAUNA (Wekiva). This crayfish is found in groundwater habitats in a limestone area along the Wekiva River in Orange and Seminole counties, Florida. It was proposed as Threatened by the Florida Committee on Rare and Endangered Plants and Animals (Franz 1982).

SPECIFIC LOCALITIES: *Orange County*: Apopka Blue Hole (USNM), Wekiwa Springs (USNM), well at Long Lake (RF). *Seminole County*: Palm Springs (USNM), well at Altamonte Springs (RF), well at Lake Brantley-type locality (ZIAS, Lonnberg 1894, 1895).

ETYMOLOGY: The name *acherontis* apparently refers to "Acheron," the name of the river of woe in Greek and Roman mythology, one of the five rivers that surrounds Hades, across which Charon ferried the dead.

REFERENCES: Cooper 1965*a* (records); Franz 1982 (conservation status, records); Franz and Lee 1982 (distribution, evolution); Hobbs 1942*b* (description, records); Hobbs et al. 1977 (description, records); Hobbs and Hobbs 1991 (key); Lonnberg 1894, 1895 (original description); Walton and Hobbs 1959 (Ul as commensal).

Procambarus (*Lonnbergius*) *morrisi* Hobbs and Franz
PUTNAM COUNTY CAVE CRAYFISH

Procambarus (*Lonnbergius*) *morrisi* Hobbs and Franz, 1990. Proceedings of Biological Society of Washington 104(1):56-62. TYPE LOCALITY: Devil's Sink, 7.1 km west of Interlachen, Putnam County, Florida. Holotype, allotype, morphotype (USNM 220374, 220375, 220376, respectively), 12 paratypes (USNM), Tom Morris (coll.), 9 May 1989, Tom Morris and Paul Smith (colls.), 6-8 March 1990.

DISTRIBUTION: ST. JOHNS RIVER FAUNA (Lake George). Known only from the type locality.

ETYMOLOGY: This crayfish is named in honor of Tom Morris, biologist and cave diver, who with Paul Smith collected the type

series and provided detailed information on Devils Sink (Hobbs and Franz 1990).

REFERENCES: Franz and Franz 1990 (listed as a new cavernicolous crayfish from Putnam County); Hobbs and Franz 1990 (original description).

Procambarus (*Ortmannicus*) *attiguus* Hobbs and Franz
SILVER GLEN SPRINGS CAVE CRAYFISH

Procambarus (*Ortmannicus*) *attiguus* Hobbs and Franz 1992. Proceedings of Biological Society of Washington 105(2):359-365. TYPE LOCALITY: Silver Glen Springs, 14.4 km northwest of Astor Park, Marion County, Florida. Holotype, allotype, and juvenile female paratype (USNM 220683, 220684, and 220685, respectively), Tom Morris (coll.), 16 August 1990 (holotype only).

DISTRIBUTION: ST. JOHNS RIVER FAUNA (Lake George). Known only from the type locality. One specimen (USNM) was taken by Mike Spelman and Mike Hill on 5 June 1991 from Silver Glen Well Cave that lies on the west side of the main spring pool and represents a secondary outflow of the main spring cave.

ETYMOLOGY: *Attiguus* from Latin meaning neighboring; alluding to the geographic proximity of the type, and only known locality, of this species to *Procambarus delicatus* at Alexander Springs, as well as to the close kinship of these two crayfishes (Hobbs and Franz 1992).

REFERENCES: Hobbs and Franz 1992 (original description).

Procambarus (*Ortmannicus*) *delicatus* Hobbs and Franz
BIG CHEEKED CAVE CRAYFISH

Procambarus (*Ortmannicus*) *delicatus* Hobbs and Franz, 1986. Journal of Crustacean Biology 6(3):509. TYPE LOCALITY: Alexander Springs, 9 km south of Astor Park, Lake County, Florida. Holotype, allotype, paratype (USNM 218528, 144848, 145578, respectively); holotype, Jeffrey B. Smith and Don Haren II (colls.).

OTHER COMMON NAMES: Alexander Springs Cave Crayfish.

DISTRIBUTION: ST. JOHNS RIVER FAUNA (Lake George). Known only from the type locality.

ETYMOLOGY: The name *delicatus* (Latin= dainty) refers to the delicate mien of this species.

REFERENCES: Franz and Lee 1982 (distribution); Hobbs and Franz 1986 (original description), 1992 (comparison with *attiguus*); Hobbs and Hobbs 1991 (key); Relyea et al. 1976 (record).

Procambarus (*Ortmannicus*) *erythrops* Relyea and Sutton
SANTA FE CAVE CRAYFISH

Procambarus (*Ortmannicus*) *erythrops* Relyea and Sutton, 1975. Tulane Studies in Zoology and Botany 19(1-2):8. TYPE LOCALITY: Sim's Sink, 1.7 km (1 mi) west of junction of U.S. Highways 27 and 129, 0.17 km (0.1 mi) south of U.S. Highway 27, Suwannee County, Florida. Holotype, allotype, morphotype (USNM 133471, 133472, 133473, respectively), 14 paratypes (USNM, RNHL, BMNH).

OTHER COMMON NAMES: Red-eyed Cave Crayfish, Sim Sink Cave Crayfish.

DISTRIBUTION: OCALA FAUNA (Upper Suwannee). Restricted to groundwater habitats in southern Suwannee County, Florida.

SPECIFIC LOCALITIES: *Suwannee County*: Azure Blue Sink (USNM), Bufo Sink (Relyea and Sutton 1975), Hildreth Cave (USNM), Quarry Sink (B. Sutton), Sim's Sink-type locality (USNM, Relyea and Sutton 1975).

ETYMOLOGY: The species name *erythrops* from "Erythros" (Gr.) for the color red, and "Ops" (Gr.) for eye; alluding to the red pigment spot in the eye of this crayfish (Relyea and Sutton 1975).

REMARKS: Bufo Sink, 0.33 km (0.2 mi) south of (Sims Sink), was listed as an unnamed sink in the original description (B. Sutton, personal communication, Gainesville, Florida).

REFERENCES: Franz 1982 (conservation status); Franz and Lee 1982 (distribution, evolution, records); Hobbs et al. 1977 (description, records); Hobbs and Hobbs 1991 (key); Mellon 1977 (eye structure); Mellon and Lnenicka 1980 (eye structure); Relyea and Sutton 1975 (original description).

Procambarus (*Ortmannicus*) *franzi* Hobbs and Lee
ORANGE LAKE CAVE CRAYFISH

Procambarus (*Ortmannicus*) *franzi* Hobbs and Lee, 1976. Proceedings of Biological Society of Washington 89(32):384. TYPE LOCALITY: Orange Lake Cave, 0.64 km (0.4 mi) south of junction of U.S. Highway 441 and State Route 318, Marion County, Florida. Holotype, allotype, morphotype, (USNM 146992, 146993, 146994, respectively), seven paratypes (USNM).

DISTRIBUTION: OCALA FAUNA (Orange Lake). Restricted to groundwater habitats in the vicinity of Orange Lake in northern Marion County, Florida.

SPECIFIC LOCALITIES: *Marion County*: Hell Hole (USNM), Orange Lake Cave-type locality (USNM, Hobbs and Lee 1976), Orange

Lake Quarry solution pipes (DSL), Trade Winds Farm Cave (USNM).

ETYMOLOGY: Named for Richard Franz who with D. S. Lee collected the type series at Orange Lake Cave (Hobbs and Lee 1976).

REFERENCES: Dickson and Franz 1980 (gill respiration); Franz 1982 (conservation status); Franz and Lee 1982 (evolution, distribution, records); Hobbs and Lee 1976 (original description); Hobbs et al. 1977 (description, records); Hobbs and Hobbs 1991 (key).

Procambarus (*Ortmannicus*) *horsti* Hobbs and Means
BIG BLUE SPRINGS CAVE CRAYFISH

Procambarus horsti Hobbs and Means, 1972. Proceedings of Biological Society of Washington 84(46): 401. TYPE LOCALITY: Big Blue Spring (tributary to the Wacissa River), 3.7 km (2.2 mi) south of the crossroads in the town of Wacissa, Jefferson County, Florida. Holotype, allotype, morphotype (USNM 132043, 132044, 132045, respectively), four paratypes (USNM), Michael N. Horst (coll.), October 1970.

Procambarus (*Ortmannicus*) *horsti*.—Holt, 1973*b*:246.

OTHER COMMON NAMES: Horst's Cave Crayfish.

DISTRIBUTION: WOODVILLE FAUNA. Confined to subterranean habitats in limestone areas of the Woodville Karst Plain in Jefferson, Leon, and Wakulla counties, Florida.

SPECIFIC LOCALITIES: *Jefferson County*: Big Blue Spring (Wacissa River)-type locality (USNM). *Leon County*: well 7.5 km (4.5 mi) east of Tallahassee (USNM). *Wakulla County*: Shepards Blue Spring (USNM). Questionable record from Wakulla Spring (see Morris 1989).

ETYMOLOGY: Named for Michael N. Horst who donated the type series to the U.S. National Museum of Natural History (Hobbs and Means 1972).

REMARKS: This crayfish is a member of the *pallidus* complex (Franz and Lee 1982).

REFERENCES: Franz 1982 (conservation status); Franz and Lee 1982 (evolution, distribution, records); Hobbs and Means 1972 (original description); Hobbs et al. 1977 (description, records); Hobbs and Hobbs 1991 (key); Morris 1989 (records).

Procambarus (*Ortmannicus*) *leitheuseri* Franz and Hobbs
COASTAL LOWLANDS CAVE CRAYFISH

Procambarus (*Ortmannicus*) *leitheuseri* Franz and Hobbs, 1983. Proceedings of Biological Society of Washington 96(2): 323. TYPE LOCALITY: Eagle's Nest Sink, 6.6 km (4.0 mi) northwest of junction

of U.S. Highway 19 and State Road 50, Hernando County, Florida. Holotype, allotype, and morphotype (USNM 178361, 178582, 178585, respectively), three paratypes (UF specimens transferred to USNM), A. T. Leitheuser and L. F. Collins (colls.).

DISTRIBUTION: OCALA FAUNA (Gulf Coastal Lowlands). Restricted to deep groundwater habitats in western Hernando and Pasco counties, Florida.

SPECIFIC LOCALITIES: *Hernando County*: Die Polders 2 Sink (USNM), Die Polders 3 Sink (USNM), Eagle's Nest Sink-type locality (USNM), Little Salt Springs (ATL), Little Springs (ATL). *Pasco County*: Arch Sink (USNM), Black Hole (USNM), Nexus Sink (USNM).

ETYMOLOGY: Named for its discoverer, Arthur T. Leitheuser, who has added much to our knowledge of the distribution of troglobitic crayfishes of Florida (Franz and Hobbs 1983).

REMARKS: This crayfish is a member of the *lucifugus* complex.

REFERENCES: Franz and Hobbs 1983 (original description); Hobbs and Hobbs 1991 (key).

Procambarus (*Ortmannicus*) *lucifugus lucifugus* (Hobbs)
WITHLACOOCHEE LIGHT-FLEEING CAVE CRAYFISH

Cambarus acherontis.—Faxon, 1898:645.

Cambarus lucifugus lucifugus Hobbs, 1940*a*. Proceedings of U.S. National Museum 89(3097):398. TYPE LOCALITY: Gum Cave (=Sweet Gum Cave), 11.2 km (7 mi) southwest of Floral City, Citrus County, Florida. Holotype, allotype, "morphotype" (USNM 77916, 77917, 77918, respectively), 32 paratypes (MCZ, USNM, FSBC, OSM), Kilby, Sherman, Hobbs Jr. (colls., holotype), 1 May 1936.

Procambarus lucifugus lucifugus.—Hobbs, 1942*a*:343 (by implication).

Procambarus (*Ortmannicus*) *lucifugus lucifugus*.—Hobbs, 1972:9.

OTHER COMMON NAMES: Florida Cave Crayfish (in part).

DISTRIBUTION: OCALA FAUNA (Withlacoochee). Restricted to groundwater habitats in Citrus and northern Hernando counties, Florida.

SPECIFIC LOCALITIES: *Citrus County*: Sweet Gum Cave-type locality (USNM, Hobbs 1940*a*). *Hernando County*: cave 23.3 km (14 mi) north of Weekiwachee Springs (USNM).

ETYMOLOGY: *Lucifugus* meaning light-fleeing, referring to its habitation of unlighted cave environments.

REMARKS: This crayfish is a member of the *lucifugus* complex (Franz and Lee 1982).

REFERENCES: Franz 1982 (conservation status); Franz and Lee 1982 (evolution, distribution, records); Hobbs 1940*a* (original description), 1942*b* (description, records); Hobbs et. al. 1977 (description, records); Hobbs and Hobbs 1991 (key); Hobbs III 1992 (photograph).

Procambarus (*Ortmannicus*) *lucifugus alachua* (Hobbs)
ALACHUA LIGHT-FLEEING CAVE CRAYFISH

Cambarus lucifugus alachua Hobbs, 1940*a*. Proceedings of U.S. National Museum 89(3097):402. TYPE LOCALITY: a small cave, Hog Sink, about 16.7 km (10 mi) west of Gainesville, Alachua County, Florida. Holotype, allotype, "morphotype" (USNM 76592), 50 paratypes (USNM, FSBC), H. H. Hobbs Jr. (coll., holotype), 30 November 1937.

Procambarus lucifugus alachua.—Hobbs, 1942*a*:343 (by implication).

Procambarus (*Ortmannicus*) *alachua*.—Hobbs, 1972:10.

OTHER COMMON NAMES: Florida Cave Crayfish (in part).

DISTRIBUTION: OCALA FAUNA (Upper Suwannee). Restricted to groundwater habitats in the Western Valley (Newberry Karst Plain) of western Alachua and northeastern Levy counties, Florida.

SPECIFIC LOCALITIES: *Alachua County*: Bat Cave (USNM), Crumbly Sink (USNM), Cueva Fria (USNM), Dudley Cave (USNM), Goat Sink (USNM), Hog Sink-type locality (USNM), Martin's Cave (Relyea and Sutton 1974), Protheroe Sink (Warren 1961), Seven Chimneys Sink (RF), Squirrel Chimney (USNM), Tusk Cave (USNM). *Levy County*: Gunpowder Cave (USNM), Williston Blue Sink (USNM).

ETYMOLOGY: The subspecific name refers to Alachua County, Florida, the area where most of the specimens of this race have been collected (RF).

REMARKS: This crayfish is a member of the *lucifugus* complex (Franz and Lee 1982).

REFERENCES: Franz 1982 (conservation status); Franz and Lee 1982 (evolution, distribution, records, photograph); Hobbs 1940*a* (original description), 1942*b* (description, records); Hobbs et al. 1977 (description, records); Hobbs and Hobbs 1991 (key); Holt 1973*b* (Cl as commensal); Lee 1969*c* (as prey).

Procambarus l. lucifugus X *l. alachua*
Intergrade populations of LIGHT-FLEEING CAVE CRAYFISHES

DISTRIBUTION: OCALA FAUNA (Lower Suwannee and Marion). The two intergrade populations appear isolated from one another and from the *P. l. lucifugus* population on the western side of the Withlacoochee

River and *P. l. alachua* population in Alachua and northeast Levy counties. The taxonomic relationships between the various populations are in need of further study.

SPECIFIC LOCALITIES: Lower Suwannee population in *Gilchrist County*: Kelley Sinks (RF), Old Walker Farm Sink (USNM), Robert's Cave (Warren 1961). *Levy County*: Friedman's Sink (USNM), Manatee Springs (USNM). Marion population in *Marion County*: Briar Cave (USNM), Chert Cave (USNM), Eickelberger Cave (USNM), Indian Cave (USNM), Ocala Caverns (USNM), Redding Catacombs (RF), Roosevelt Cave (USNM), Silver Springs (USNM), Steeple Cave (RF), Sunday Sink (USNM), Waldo Cave (Warren 1961).

REFERENCES: Cooper 1965*b* (records); Franz 1982 (conservation status); Franz and Lee 1982 (evolution, distribution, records); Hobbs 1942*b* (description, records); Hobbs et al. 1977 (description, records); Holt 1973*b* (Cl as commensal).

Procambarus (*Ortmannicus*) *orcinus* Hobbs and Means

WOODVILLE KARST CAVE CRAYFISH

Procambarus pallidus.—Hobbs 1958:81 (part).

Procambarus orcinus Hobbs and Means, 1972. Proceedings of Biological Society of Washington 84(46):394. TYPE LOCALITY: Gopher Sink, 5 km (3.1 mi) southwest of State Road 61 and 0.3 km (0.2 mi) east of State Route 369, Leon County, Florida. Holotype, allotype, morphotype (USNM 132031, 132032, 132033, respectively), 21 paratypes (USNM).

Procambarus (*Ortmannicus*) *orcinus*.—Hobbs, 1972:58.

DISTRIBUTION: WOODVILLE FAUNA. Apparently restricted to groundwater habitats in the limestone areas of the western Woodville Karst Plain in Leon and Wakulla counties, Florida.

SPECIFIC LOCALITIES: *Leon County*: Bird Sink Swallet (USNM), cave 5 km (3 mi) north of Woodville (USNM), Clay Sink (USNM, Warren 1961), Culley's Cave (USNM), Falcon's Nest (USNM), Gopher Sink-type locality (USNM, Hobbs and Means 1972), Little Dismal Sink (USNM), Osgood Sink (USNM), Sullivan's Tunnel (USNM). *Wakulla County*: Emerald Sink (USNM), Indian Springs (USNM), McBride Spring (USNM), Sally Ward Spring (Morris 1989), River Sinks (Caine 1978), Wakulla Springs (USNM).

ETYMOLOGY: The species name *orcinus* (L.) for the nether world, referring to the spelean habitat of this crayfish (Hobbs and Means 1972).

REMARKS: Franz and Lee (1982) listed this crayfish as a member of the *pallidus* complex.

REFERENCES: Caine 1978 (ecology, records); Franz 1982 (conservation status, records); Franz and Lee 1982 (evolution, distribution, records); Hobbs and Means 1972 (original description); Hobbs et al. 1977 (description, records); Hobbs and Hobbs 1991 (key); Holt 1973*b* (Cl as commensal).

Procambarus (*Ortmannicus*) *pallidus* (Hobbs)

PALLID CAVE CRAYFISH

Cambarus acherontis.—Hobbs, 1937:154.

Cambarus acherontis pallidus Hobbs, 1938:90-91. Nomen nudum.

Cambarus pallidus Hobbs, 1940*a*. Proceedings of U.S. National Museum 89(3097):394. TYPE LOCALITY: Warren Cave, 17.6 km (11 mi) northwest of Gainesville, Alachua County, Florida. Holotype, allotype (both listed as USNM 76591), 13 paratypes (USNM, MCZ, FSBC), H. H. Hobbs, Jr. et al. (colls., holotype).

Procambarus pallidus.—Hobbs, 1942*a*:343 (by implication).

Procambarus (*Ortmannicus*) *pallidus*.—Hobbs, 1972:10.

DISTRIBUTION: OCALA FAUNA (Upper Suwannee). Groundwater habitats in limestone areas of the (northern) Withlacoochee River, upper Suwannee River, lower Santa Fe River, and the Newberry Karst Plain (western Alachua and northeast Levy counties), Florida. The species may eventually be discovered in karst areas along the Withlacoochee River in southern Georgia because the M2 Cave site in Madison County (Florida) lies 9 km (6 mi) south of the Florida-Georgia border.

SPECIFIC LOCALITIES: *Alachua County*: Alachua Sink (USNM), Chimney Sink (USNM), Cueva Fria (USNM), Devil's Hole (USNM), Goat Sink (USNM), Hertzog Cave (USNM), High Springs Cave (USNM), Hog Sink (USNM), Hornsby Sink (USNM), Hornsby Spring (ATL), McGeehee Blue Hole Cave (ATL), Pallidus Sink (USNM), Protheroe Sink (Warren 1961), Squirrel Chimney (USNM), Still Sink (USNM), Warren Cave-type locality (USNM, Hobbs 1940*a*), well at Fort Clark (USNM), 32-Foot Cave (RF). *Columbia County*: Big Grungy Swallet (USNM), Big Room Cave (TM), Bussey's Sink (USNM), Columbia Spring (TM), Fossil Cave Sink (TM), Riverbed Cave (USNM), Rose Creek Swallet (USNM), Rose Creek Overflow Cave (TM), Russell's Rub (TM), Shiloh Cave (USNM). *Gilchrist County*: Devil's Eye and Ear Spring (USNM), Ginnie Springs (RF), Rocky Bluff Spring (USNM). *Hamilton County*: Adams Spring (TM), Corbett Spring Cave (USNM), Firecracker Cave (USNM), Overflow Cave (USNM), Pott Spring (TM), Rossiter Spring (TM), Shallow Spring (ATL), Underhung Sink (USNM). *Lafayette County*: Alligator Rescue Spring (TM), Allens Mill Pond Spring (USNM), Kassermans Sink (ATL), Lafayette Blue Spring (ATL),

Main Sink (ATL), Owens Spring (TM), Perry Spring (ATL), Ruth Spring (USNM), Troy Spring (USNM). *Levy County*: Archer Caves (RF), Devils Den (USNM). *Madison County*: Baseline Cave (USNM), Madison Blue Spring (ATL), M2 Blue Cave (USNM), Suwannacoochee Spring (USNM), Thunderhole Sink (USNM). *Suwannee County*: Anderson Spring (TM), Bonnett Spring (TM), Challenge Sink (TM), Charles Spring (TM), Cisteen Sink (USNM), Cow Spring Cave (USNM), Crazy Horse Sink (USNM), Double Sink (ATL), Edwards Spring (USNM), Falmouth Spring (JB), Ghoul Sink (USNM), Irvine Slough Spring (TM), Lineater Spring (TM), Little River Spring (USNM), Mirkwood Sink (USNM), Olsen Sink (TM), Orange Grove Sink (USNM), Peacock Spring (USNM), unnamed sink in Peacock System (USNM), Peacock Sink 3 (JB), Pot Hole (JB), Register Sink (ATL), Sandbag Spring (TM), Smith Sink (ATL), Stick Sink (ATL), Telford Springs (USNM), Ten Mile Hollow Cave (TM), Water Hole 3 Sink (JB).

ETYMOLOGY: The name *pallidus* refers to the pallid appearance of this cave species (RF).

REMARKS: The record from Eichelberger Cave in Marion County (Hobbs et al. 1977) was questioned by Franz and Lee (1982). Crayfishes from the Big Grungy population are less tuberculate and spiniform than more typical *P. pallidus* (HHH). We encourage the collections of more specimens from this site in order to resolve its taxonomic status. *P. pallidus* is a member of the *pallidus* complex (Franz and Lee 1982).

REFERENCES: Cooper 1965*b* (records); Dickson and Franz 1980 (gill respiration); Franz 1982 (conservation status, records); Franz and Lee 1982 (evolution, distribution, records); Hobbs 1940*a* (original description), 1942*a*, 1942*b* (descriptions, records); Hobbs et al. 1977 (descriptions, records); Hobbs and Hobbs 1991 (key); Relyea and Sutton 1973*a* (egg-bearing); Streever 1992*b* (crayfish kill at Peacock Springs); Walton and Hobbs 1959 (Cl as commensal).

Troglocambarus maclanei Hobbs
NORTHERN SPIDER CAVE CRAYFISH

Troglocambarus maclanei Hobbs, 1942*a*. American Midland Naturalist 28(2):345. TYPE LOCALITY: Squirrel Chimney, 17.6 km (11 mi) northwest of Gainesville, Alachua County, Florida. Holotype, allotype, paratypic male (form II) (USNM 79385, 79386, 79387, respectively), other paratypes (MCZ, USNM). H. H. Hobbs (coll., holotype), 25 March 1941.

OTHER COMMON NAMES: Spider Cave Crayfish (in part), McLane's Cave Crayfish.

DISTRIBUTION: OCALA FAUNA (Upper Suwannee, Lower Suwannee, Orange Lake, Marion, Withlacoochee, and Gulf Coastal Lowlands). *Troglocambarus maclanei* is the most widely distributed troglobitic crayfish in Florida. It ranges from southern Suwannee County, southwestward to Pasco County. Based on the sighting of a shrimp-like crayfish in Knight Sink, near Tarpon Springs, this species may range south into Pinellas County (P. Heinerth, personal communication, Hudson, Florida).

SPECIFIC LOCALITIES: *Alachua County*: Goat Sink (USNM), Hertzog Cave (USNM), Squirrel Chimney-type locality (USNM, Hobbs 1942*a*). *Columbia County*: Columbia Spring (TM), Fossil Cave Sink (TM). *Gilchrist County*: Devil's Eye and Ear Spring (USNM). *Hernando County*: Eagle's Nest Sink (USNM). *Levy County*: Manatee Springs (USNM), Peanut Cave (USNM). *Marion County*: Chert Cave (USNM), Indian Cave (USNM), Orange Lake Cave (USNM), Sunday Sink (RF), Trade Winds Farm Sink (USNM). *Suwannee County*: Azure Blue Sink (USNM), Sim's Sink (USNM).

ETYMOLOGY: Named for William A. McLane, collector of the original specimens.

REFERENCES: Cooper 1965*b* (records); Franz 1982 (conservation status, records, photograph); Franz and Lee 1982 (evolution, distribution, records); Franz and Franz 1990 (distribution); Hobbs 1942*a* (original description, photograph), 1942*b* (description, records, photograph); Hobbs et al. 1977 (description, records); Hobbs and Hobbs 1991 (key); Holt 1973*b* (Cl as commensal); Mohr and Poulson 1966 (photo).

Troglocambarus sp.
ORLANDO SPIDER CAVE CRAYFISH

DISTRIBUTION: ST. JOHNS RIVER FAUNA (Wekiva). Known only from Apopka Blue Sink, Orange County, Florida (USNM). This cave may represent an upstream part of the Rock Spring Cave System. REMARKS: Specific identification of this crayfish awaits the collection of Form I males (HHH).

REFERENCES: Hobbs III 1992 (photograph).

Cambarus (*Jugicambarus*) *cryptodytes* Hobbs
APALACHICOLA CAVE CRAYFISH

Cambarus (*Cambarus*) *cryptodytes* Hobbs. 1941. American Midland Naturalist 26(1):110. TYPE LOCALITY: well on the R. W. Williams farm, 3.2 km (2 mi) south of Graceville, Jackson County,

Florida. Holotype, allotype, morphotype (USNM 79339, 79340, 79343, respectively), five paratypes (MCZ, USNM).

Cambarus cryptodytes.—Hobbs, 1942*a*:354.

Cambarus (*Jugicambarus*) *cryptodytes*.—Hobbs, 1969:107.

OTHER COMMON NAMES: Marianna Lowlands Cave Crayfish, Dougherty Plain Cave Crayfish. We propose the new common name, Apalachicola Cave Crayfish, which we believe better reflects this species and its distribution.

DISTRIBUTION: APALACHICOLA FAUNA (Marianna and Southwest Georgia). Groundwater areas of northcentral Jackson County, Florida, and Decatur County, Georgia.

SPECIFIC LOCALITIES: *Jackson County*: Cave-in-Woods (RF), Ellis Cave (USNM), Gerard Cave (USNM), Gerome's Cave (Hobbs et al. 1977), Hole-in Wall (USNM), Jackson Blue Spring (USNM), Judges Cave (Warren 1961), Miller's Cave (DSL), Milton's Well Cave (DSL), Pool Cave (Hobbs et al. 1977), Pottery Cave (Warren 1961), Ray's Cave (FNAI), Rockwell Cave (Hobbs et al. 1977), Soda Straw Cave (Warren 1961), Twin Cave (USNM), Vetter's Cave (Hobbs et al. 1977), Waddell's Mill Cave (USNM), Washed-out Cave (Warren 1961), well 3.3 km (2 mi) south of Graceville-type locality (USNM, Hobbs 1941). *Decatur County* (Georgia): Climax Cave (USNM).

REMARKS: The type locality was an 18.2-m (60 ft) deep well on the farm of Robert W. Williams. During a 1983 visit with Mr. Robert Williams, who obtained the original series for Hobbs, we learned that the well had been filled many years before. The Washington County specimen mentioned by Hobbs (1989), we believe, must have come from Jackson County (probably Gerards Cave), based on road mileage listed with the specimen. Unusual specimens of *Cambarus* were recently collected at Blue Hole in Florida Caverns State Park by park rangers and at Vortex Spring in Holmes County that may represent one or more distinct taxon (HHH). Adult material is necessary before this taxonomic problem can be resolved.

ETYMOLOGY: Crypto from the Greek=hidden, dytes=to dwell, referring to the crayfish dwelling in the cave environment.

REFERENCES: Franz 1982 (conservation status); Franz and Lee 1982 (evolution, distribution, records); Harris 1968 (associate of *Haideotriton*); Hobbs 1941 (original description), 1942*a*, 1942*b* (description, records), 1969 (taxonomy), 1981 (description, records in Georgia); Hobbs et al. 1977 (description, records); Hobbs and Hobbs 1991 (key); Hobbs and Walton 1968 (Uw as commensal); Pylka and Warren 1958 (records); Warren 1961 (records).

Class INSECTA
Order COLLEMBOLA
Family Entomobryidae
Pseudosinella pecki Christiansen and Bellinger
MARIANNA CAVE SPRINGTAIL

Pseudosinella pecki Christiansen and Bellinger, 1980. Grinnell College Special Paper: 988-989pp. TYPE LOCALITY: Miller's Cave, (Florida) Caverns State Park, Jackson County, Florida. S. B. Peck (coll.), 28 December 1965.

DISTRIBUTION: APALACHICOLA FAUNA (Marianna Lowlands and Southwest Georgia). Known from caves in Jackson County (Florida), Jackson County (Alabama), and Decatur, Randolph, and Stewart counties, Georgia (Christiansen and Bellinger 1980).

REMARKS: According to Christiansen and Bellinger (1980), this species is probably a troglobitic derivative of *Pseudosinella argentea*.

ETYMOLOGY: Named for Stewart B. Peck, collector of the collembolan.

REFERENCES: Peck 1970 (record); Christiansen and Bellinger 1980 (original description).

Class ARCHNIDA
Order ARANEA
Family Linyphiidae
Islandiana sp.
MARIANNA CAVE SHEETWEB WEAVER SPIDER

DISTRIBUTION: APALACHICOLA FAUNA (Marianna Lowlands). This undescribed spider is known only from Miller's Cave, Florida Caverns State Park, Jackson County, Florida. REMARKS: This spider is currently under study by W. T. Gertsch (S. B. Peck, personal communication, Carlton University).

REFERENCES: Peck 1970 (record).

Phylum CHORDATA
Class AMPHIBIA
Order CAUDATA
Family Plethodontidae
Haideotriton wallacei Carr
GEORGIA BLIND SALAMANDER

Haideotriton wallacei Carr, 1939. Occasional Papers of Boston Society of Natural History 8:335-336. TYPE LOCALITY: 60.8-m (200

ft) deep well in Albany, Dougherty County, Georgia. Holotype (MCZ 19875), Mr. Hummel (Dougherty County Sanitary Engineer) (coll.), 19 May 1939.

DISTRIBUTION: APALACHICOLA FAUNA (Marianna Lowlands and Southwest Georgia). Restricted to groundwater habitats in Jackson County, Florida, and Decatur and Dougherty counties, Georgia. This salamander was listed as Rare by the Florida Committee on Rare and Endangered Plants and Animals (Means 1978, 1992).

SPECIFIC LOCALITIES: FLORIDA, *Jackson County*: Cave-in-Woods (RF), Ellis Cave (DSL), Gerard's Cave (UF, USNM, NCSM, MCZ, Pylka and Warren 1958), Hole-in-Wall Cave (UF), Jackson Blue Spring (RF), Judges Cave (DSL), Miller's Cave (DSL), Milton's Well Cave (DSL), Twin Cave (RF), Washed-out Cave (Warren 1961). GEORGIA, *Decatur County*: Climax Cave (UF). *Dougherty County*: well in Albany (MCZ).

ETYMOLOGY: Named for H. K. Wallace, spider expert and Carr's colleague at the University of Florida, Gainesville.

REFERENCES: Carr 1939 (original description, photo); Bishop 1947 (description, photo); Brandon 1967 (description, literature); Dundee 1962 (response to metamorphic agent); Franz and Lee 1982 (crayfish associate); Harris 1968 (ecology); Hilton 1945 (skeleton); Hobbs III 1992 (photo); Lee 1969*a* (food habits), 1969*b*; Means 1977 (distribution), 1978, 1992 (conservation); Mohr and Poulson 1966 (photo); Peck 1973 (feeding efficiency); Valentine 1964 (morphology); Vandel 1965*a* (records); Wake 1966 (taxonomy); Pylka and Warren 1961 (record).

SUMMARY—The troglobitic fauna is composed of three isopods, two amphipods, one shrimp, 18 crayfishes (including two subspecies and two intergrade populations), one snail, one spider, one springtail, and one salamander. At least one species (*Caecidotea hobbsi*) occurs in groundwater habitats outside of caves, *per se*; the amphipods (*Crangonyx hobbsi* and *Crangonyx grandimanus*) also may use similar habitats, particularly in light of their wide geographic distributions. Several taxa in this list remain undescribed, due to the lack of critical material in collections. Faunas and assemblages are described in the section entitled *Obligate Cave Faunas and Karst Regions*.

ANNOTATED LIST OF OTHER CAVE-ASSOCIATED SPECIES

Phylum ANNILIDA
Class OLIGOCHAETA
Family Branchiobdellidae

Cambarincola leoni Holt (commensal on troglobites). *Alachua County:* on *Troglocambarus maclanei* from Squirrel Chimney; on *Procambarus lucifugus alachua* from Goat Sink. *Leon County*: on *Procambarus orcinus* from Gopher Sink. *Marion County*: on *Procambarus lucifugus* X *alachua* from Indian Cave. REMARKS: Holt (1973*b*) lists questionable records of this species on crayfishes from Squirrel Chimney (Alachua County), The Bat Hole (=Roberts Cave) (Gilchrist County), and Sim's Sink (Suwannee County).

Cambarincola manni Holt (accidental?). *Seminole County*: on *Procambarus acherontis* from Palm Spring (Holt 1973*b*). REMARKS: This annelid also has been retrieved from epigean crayfishes (*Procambarus alleni*, *P. fallax*, *P. paeninsulanus*) (Holt 1973*a*). Its presence on *Procambarus acherontis* may have been fortuitous because the specimens were acquired from crayfishes found in the spring pool at Palm Springs rather than from the adjacent cave environment. Infestations may have originated with surface crayfishes coinhabiting the spring pool.

Other Branchiobdellid Annelids. Unidentifiable branchiobdellid materials were collected on *Procambarus erythrops* (listed as *Procambarus lucifugus*) from Sim's Sink (Suwannee County), on *Procambarus horsti* from Big Blue Spring (Jefferson County), and on *Cambarus cryptodytes* from Gerard's Cave (Jackson County) and Climax Cave (Decatur County, GA) (Holt 1973*b*).

Other Annelids. Aeolosomatid oligochaetes were reported as part of the benthos from the cave tunnel and from the shallower regions of Vortex Blue Spring in Holmes County (Helfman 1986). Other caves with populations of aquatic annelids include: *Columbia County*: Rose Creek Swallet and Overflow (TM), Blue Sink (TM). *Hamilton County*: Shallow Spring (TM), Rossiter Spring (TM). *Madison County*: Thunderhole (TM). *Suwannee County*: Alligator Rescue Spring (TM), Bonnett Spring (TM), Charles Spring (TM), Irvine Slough Spring (TM), Peacock Springs (TM, Streever 1992*b*), Lineater Spring (TM), Telford Spring (TM), Water Hole Cave (TM).

Phylum MOLLUSCA
Class BIVALVIA
Family Cyrenidae

Corbicula fluminea (O.F.M.) (troglophile?). *Columbia County*: Siphon Creek Cave (TM); *Lafayette County*: Green Sink (TM); *Suwannee County*: Peacock Springs Cave (Streever 1992*a*).

Family Unionidae

Uniomerus obesus (Lee) (trogloxene?). *Columbia County*: Rose Creek Swallet (James D. Williams, personal communication, National Biological Survey, Gainesville, Florida). REMARKS: Mussels were collected alive buried in hard sand on the floor of this spring cave between the entrance and 60 meters penetration at water depths up to 12 meters. Their distribution in the cave probably is limited by the availability of filterable foods and the abilities of the host fish that carry the parasitic glochidia to penetrate subterranean habitats. The food supply may include the thin veneer of organic silt that covers the sand at this site.

Class GASTROPODA
Subclass PROSOBRANCHIA
Family Pleuroceridae

Elimia clenchi (Goodrich), Slackwater Elimia (trogloxene). *Holmes County*: Vortex Blue Spring (Helfman 1986). REMARKS: Reported as benthos from the cavern portion of Vortex Spring, but not from the deeper portions of the cave.

Elimia curvicostata (Reeve), Graphite Elimia (trogloxene). *Washington County*: Econfina Blue Springs Cave (RF, Thompson and Hershler 1991). REMARKS. This species was collected with the troglobitic snail, *Dasyscias franzi*, in the cave. *Elimia curvicostata* also occurred in the outflow and spring pool of Econfina Blue Spring; other snail species, including *Elimia athearni*, were found in the spring pool but not in the cave stream.

Family Hydrobiidae

Amnicola retromargo Thompson (troglophile). *Hamilton County*: Shallow Spring (FGT). REMARKS: These snails were collected approximately 60-600 meters inside the cave (water depth 12 meters) on boulders on the floor and on the cave walls in strong water currents. These specimens were lighter in color than individuals found in surface streams (F. G. Thompson personal communication, Florida Museum of Natural History).

Family Thiaridae

Melanoides tuberculatus (Mueller) (trogloxene?) *Citrus County*: Restinghouse Siphon (FGT). REMARKS: This snail is introduced from southeast Asia. It was found on the floor of this flooded cave between 0-60 meters penetration and at water depths up to 12 meters.

Tarebia granifera (Lamarck) (trogloxene?). *Citrus County*: Restinghouse Siphon (FGT). REMARKS: This snail is introduced from southeast Asia. This snail was found in association with *Melanoides tuberculatus* on the cave floor between 0-60 meters penetration and at water depths up to 12 meters.

Subclass PULMONATA
Family Endodontidae

Anguispira alternata (Say) (trogloxene). *Jackson County*: caves (Franz et al. 1971).

Family Haplotrematidae

Haplotrema concavum (Say) (trogloxene). *Jackson County*: caves (Franz et al. 1971).

Family Oleacinidae

Euglandina rosea (Ferussac) (trogloxene). *Jackson County*: Gerome's Cave, Kramers cave, Milton's Well Cave, Pottery Cave, River Cave, Vetter's Cave (Franz et al. 1971). *Washington County*: Falling Waters Trail Cave (Franz et al. 1971). REMARKS: Nests with eggs of this snail were reported from several caves in Jackson County (Franz et al. 1971).

Family Polygyridae

Mesodon inflectus (Say) (trogloxene). *Jackson County*: caves (Franz et al. 1971).

Mesodon thyroidus (Say) (trogloxene). *Jackson County*: caves (Franz et al. 1971).

Triodopsis hopetonensis (Shuttleworth) (trogloxene). *Alachua County*: Bat Cave (FGT).

Family Zonitidae

Vintridens demissus (Binney) (trogloxene). *Jackson County*: caves (Franz et al. 1971).

Family Planorbidae

Gyraulus parvus (Say), Ash Gyro (trogloxene?). *Alachua County*: Bat Cave (FGT). REMARKS: The presence of this snail and *Promenetus* in Bat Cave is puzzling. The cave is located in the Newberry Karst Plain and is not close to any standing or flowing bodies of surface water (RF).

Promenetus sp. (trogloxene?). *Alachua County*: Bat Cave (FGT).

Unidentified snails. *Madison County*: Madison Blue Spring (TM).

Phylum ARTHROPODA
Class CRUSTACEA
Subclass OSTRACODA

Family Entocytheridae

Uncinocythere ambophora (Walton and Hobbs) (commensal on troglobites). *Putnam County*: on *Procambarus morrisi* at Devil's Sink (Hobbs and Franz 1990). *Seminole County*: on *Procambarus acherontis* at Palm Springs (Walton and Hobbs 1959).

Uncinocythere equicurva (Hoff) (trogloxene?). Reported by Hoff (1944) on *Procambarus lucifugus alachua* (specific data not mentioned); also known on surface crayfishes (Hoff 1944); identity questioned by Walton and Hobbs (1959).

Uncinocythere lucifuga (Walton and Hobbs) (commensal on troglobites). *Alachua County*: on *Procambarus lucifugus alachua* from Hog Sink; on *Procambarus pallidus* from Squirrel Chimney (Walton and Hobbs 1959). *Marion County*: on *Procambarus franzi* from Orange Lake Cave (A. Norden, personal communication, Maryland Natural History Society, Baltimore).

Uncinocythere warreni Hobbs and Walton (commensal on troglobites). *Decatur County, Georgia*: on *Cambarus cryptodytes* from Climax Cave (Hobbs and Walton 1968). REMARKS: This ostracod also should occur on *Cambarus cryptodytes* in caves of Jackson County, Florida.

Other Ostracods. REMARKS: Lee (1969*a*:175) reported "Six species of ostracods of the families Canoninae and Cypridacea... including one specimen identified to the genus *Darwinula*" from the gut of *Haideotriton wallacei* from Gerards Cave in Jackson County.

Subclass EUCOPEPODA

Unidentified copepods. Lee (1969*a*) reported finding copepods in the gut of *Haideotriton wallacei* from Gerards Cave. Hobbs (1942*b*)

also mentioned copepods from Gum Cave. Other copepod records include *Columbia County*: Jug Spring (TM); *Gilchrist County*: Devil's Eye and Ear Spring (TM). *Leon County*: Little Dismal Sink (TM). *Levy County*: Gunpowder Sink (TM). *Marion County*: Silver Springs (TM); *Suwannee County*: Charles Spring (TM), Irvine Slough Spring (TM). REMARKS: Copepods frequently were found in association with catfish feces (TM).

Subclass MALACOSTRACA
Order ISOPODA
Family Trichoniscidae

Miktoniscus alabamensis Muchmore (troglophile). *Jackson County*: Florida Caverns, Miller's Cave (Vandel 1965*a*, 1965*b*; Peck 1970).

Order AMPHIPODA
Family Crangonyctidae

Crangonyx floridanus Bousfield (troglophile). *Dade County*: well at Little Bird Nusery and Garden Store in Miami (JRH). *Jackson County*: China Cave (JRH), Gerard's Cave (Lee 1969*a*), Geromes Cave (JRH), Judges Cave (JRH), Millers Cave (JRH), Pool Cave (JRH). *Suwannee County*: Azure Blue Sink (JRH). REMARKS: The type series of this amphipod was collected in a swamp at Highlands Hammock State Park, Florida (Bousfield 1963). It also has been taken from a swamp in St. Tammany Parish, Louisiana (Holsinger 1972). Specimens from the well in Miami do not differ from those in northern Florida and do not represent an undescribed subspecies as suggested earlier by Holsinger (1972; personal communication, Old Dominion University).

Family Talitridae

Hyallela azteca (Saussure) (trogloxene). *Holmes County*: Vortex Blue Spring (Helfman 1986). REMARKS: Reported as part of the benthos from the cave tunnel and from the shallower cavern region at Vortex Spring.

Order DECAPODA
Family Cambaridae

Procambarus alleni (Faxon) (trogloxene). *Monroe County*: shallow solution channels on Big Pine Key (DSL).

Procambarus paeninsulanus (Faxon) (trogloxene). *Jackson County*: Gerome's Cave (DSL). REMARKS: This crayfish was abundant in the

main cave pool at Geromes Cave; ovigerous females were found in burrows constructed in bat guano along its bank (DSL).

Procambarus fallax (Hagen) (trogloxene). Alachua County: Alachua Sink (Hobbs et al. 1977).

Family Palaemonidae

Marcobrachium carinus (L.) (accidental?). *Marion County*: Silver Glen Spring (Hobbs and Franz 1992), Silver Springs (Tom Allen, personal communication, formerly Gainesville, Florida). REMARKS: This shrimp has been encountered in the entrances of spring caves in the lower St. Johns River system. Prior to the building of Rodman Dam, the species once was common in Silver Springs; it apparently has been extirpated from this site (Tom Allen, personal communication). Specimens have been retrieved from the stream below the dam as recently as 1990.

Palaemonetes paludosa (Gibbes) (accidental?). *Columbia County*: Siphon Creek Cave (TM). *Gilchrist County*: Devils Eye and Ear Spring (TM). *Hernando County*: Die Polder 3 (PH), Eagles Nest (TM). *Leon County*: Gopher Sink (Hobbs and Means 1972). *Wakulla County*: Sally Ward Spring (TM), Wakulla Springs (TM). REMARKS: Specimens have been seen at water depths near 60 m in Die Polders 3 (TM). An unusual specimen of *Palaemonetes* was collected in Silver Springs that warrants additional study (HHH). This specimen may represent an undescribed taxon.

Palaemonetes kadiakensis Rathbun (accidental?). Leon County: Bird Sink (USNM). REMARKS: Two females were collected in the dark zone, 60 m inside the cave in September 1993 (B. Pruitt, pers. comm.).

Family Portunidae

Callinectes sapidus Rathbun (accidental?). *Marion County*: Salt Springs (RF), Silver Glen Springs (Hobbs and Franz 1992). REMARKS: Female blue crabs commonly invade the mouths of springs around Lake George on the St. Johns River during their annual migrations.

Other Crustaceans. An unstudied crab (trogloxene?) was collected in the cave at Silver Glen Springs, Marion County (HHH).

Class INSECTA

Order COLLEMBOLA

Family Isotomidae

Isotoma notabilus Schaffer (troglophile). *Alachua County*: Warren Cave (Peck 1970).

Family Tomoceridae

Tomocerus dubius Christiansen (troglophile). *Alachua County*: Warren Cave (Peck 1970). *Jackson County*: Miller's Cave (Peck 1970).

Order ORTHOPTERA
Family Gryllacrididae

Ceuthophilus gracilipes (Haldeman) (trogloxene). *Jackson County*: Bat Cave, Blue Spring Cave, Florida Caverns, Gerard's Cave, Miller's Cave, small cave near Judges Cave (Hubbell 1936, Peck 1970).

Ceuthophilus latibuli Scudder (trogloxene). *Alachua County*: Bat Cave, Dudley Cave, Grant's Cave, Jook Cave, O'Steen's Cave, Warren Cave (Hubbell 1936, Peck 1970). *Citrus County*: Blowing Hole Cave, Dr. Doans (Dames) Cave (Hubbell 1936, Peck 1970). *Marion County*: Belleview Cave, Jennings Cave, Waldo Cave (Hubbell 1936, Peck 1970).

Ceuthophilus virgatipes Rehn & Hebard (trogloxene). *Alachua County*: Dudley Cave (Hubbell 1936, Peck 1970). *Marion County*: Villa Height's Cave (Hubbell 1936, Peck 1970).

Order COLEOPTERA
Family Leiodidae

Nemadus sp. (troglophile). *Alachua County*: Warren Cave (Peck 1970). *Jackson County*: Gerard's Cave (Peck 1970).

Prionchaeta opaca (Say) (troglophile). *Jackson County*: Gerard's Cave, Miller's Cave (Peck 1970).

Ptomaphagus cavernicola Schwarz (troglophile). *Alachua County*: Warren Cave (Peck 1970). *Jackson County*: Gerard's Cave (Lee 1969*a*). REMARKS: Lee (1969*a*) found this beetle in the stomaches of *Haideotriton wallacei* from Gerard's Cave. Although it is found regularly in caves from Mexico to Florida, this beetle recently was recorded away from caves in mixed pine and deciduous forests of floodplain loam or sandy soils in Jackson, Leon, and Suwannee counties, Florida, and in Macon County, Georgia (Peck 1982). Peck (1982) concluded that *P. cavernicola* is a contemporary inhabitant of forests of the southeastern United States, is not cave-limited or a Recent climatic relict, and probably can colonize suitable cave sites.

Family Dytiscidae

Hydroporus clypealis Sharp (accidental?). *Alachua County*: Devil's Hole (Hobbs 1942*b*, Young 1942).

Family Staphylinidae

Atheta (*Atheta*) *annexa* Casey (trogloxene). *Jackson County*: Miller's Cave (Klimaszewski and Peck 1986).

Atheta (*Dimetrota*) *lucifuga* Klimaszewski and Peck (trogloxene). *Jackson County*: Miller's Cave (Klimaszewski and Peck 1986).

Atheta (*Dimetrota*) *troglophila* Klimaszewski and Peck (troglophile). *Jackson County*: Miller's Cave (Klimaszewski and Peck 1986).

Family Catopidae

Unidentified catopid beetle. Lee (1969*a*) reported these beetles in the gut of *Haideotriton wallacei* from Gerards Cave.

Family Carabidae

Rhadine larvalis LeConte (troglophile). *Jackson County*: "from at least one Marianna area cave" (T. C. Barr, Jr., personal communication, University of Kentucky). REMARKS: This beetle also was found in Turk's Cave, near Evergreen, Conecuh County, Alabama, and could occur in any Florida cave (T. C. Barr, Jr., personal communication).

Order DIPTERA

Family Nycteribiidae

Basilia boardmanii Rozeboom (trogloxene). *Marion County*: on *Myotis austroriparious* from Orange Lake Cave. (James Bain, personal communication, Flagstaff, Arizona).

Family Streblidae

Trichobius major Coquillet (trogloxene). *Citrus County*: Sweet Gum Cave (Hubbard 1901). *Marion County*: on *Myotis austroriparious* from Orange Lake Cave (James Bain, personal communication).

Class ARACHNIDA

Order UROPYGI

Family Thelyphonidae

Mastigoproctus giganteus (accidental). *Citrus County*: Sweet Gum Cave (Hobbs 1942*b*). REMARKS: Listed as *Thelyphonus giganteus* by Hobbs (1942*b*).

Order OPILIONES

Family Phalangodidae

Phalangodes (*Bishopella*) *laciniosa* Crosby & Bishop (troglophile). *Jackson County*: Florida Caverns (listed as *P. marianna* by Goodnight and Goodnight 1942, 1953).

Phalangodes (*Crosbyella*) *spinturnix* Crosby and Bishop (troglophile). *Jackson County*: Gerard's Cave, Milton Cave, Miller's Cave (Peck 1970).

Order ARANEAE

Family Argiopidae

Azilla affinis (Simon) (troglophile). *Jackson County*: "Spring Cave" and "Two Entrance Cave" in Florida Caverns State Park (Peck 1970). REMARKS: Listed by Peck (1970) as *Azilla vagepicta* Simon. Levi (1980) suggested the use of *A. affinis* instead of *A. vagepicta*.

Family Linyphiidae

Centromerus latidens (Emerton) (troglophile). *Jackson County*: (Old) Indian Cave (Peck 1970). REMARKS: An undetermined female *Centromerus* also was collected in Dr. Dames Cave, Citrus County (Peck 1970).

Family Nesticidae

Gaucelmus augustinus Keyserling (troglophile). *Alachua County*: Bat Cave, Dudley Cave, Squirrel Chimney, Warren Cave (Peck 1970, Gertsch 1984). *Citrus County*: "caves," small cave 8 km (5 mi) north of Dr. Dames Cave, Dr. Dames Cave (Peck 1970, Gertsch 1984)). *Jackson County*: Florida Caverns, Milton's Cave, (Waddells) Mill Pond Cave, Miller's Cave (Peck 1970, Gertsch 1984). *Marion County*: Mefford Cave (Gertsch 1984, Peck 1970)

Eidmannella pallida (Emerton) (troglophile). *Alachua County*: Bat Cave, Grant's Cave, Dudley Cave (Peck 1970, Gertsch 1984). *Citrus County*: Blowing Hole Cave, Dr. Dames Cave (Peck 1970, Gertsch 1984). *Jackson County*: cave near Gerards Cave, Florida Caverns, Gerard's Cave, Judges Cave, Miller's Cave, (Miltons) Well Cave No.1, (Waddells) Mill Pond Cave, Old Indian Cave (Peck 1970, Gertsch 1984) REMARKS: New name combination was suggested by Gertsch (1984). Formerly called *Nesticus pallidus*.

Family Cteniidae

Ctenus captiosus (troglophile?). Probably in Florida caves (Edwards 1989).

Order ACARI

Unidentified mites. Lee (1969*a*) reported a single mite in the gut of a *Haideotriton wallacei* from Gerard's Cave.

Class DIPLOPODA

Family Cambalidae

Cambala annulata (Say) (troglophile). *Jackson County*: Gerard's Cave, Indian Cave, Judges Cave, Miller's Cave, Milton's Cave (Peck 1970).

Class CHILOPODA

Family Lithiobiidae

Lithobius atkinsoni Bollman (troglophile). *Jackson County*: Gerard's Cave, Milton's Cave (Peck 1970).

Other Invertebrates. P. Heinerth (personal communication) found sponges on divers' guide lines that extended into Black Hole, Pasco County. This cave lies in a tidal marsh near the Gulf of Mexico. The water in the sink is usually heavily stained by tannins, which accounts for the cave's name. In addition, colonies of freshwater colonial cnidarians, *Cordylophora lacustris*, and several types of zooplankton were reported from Little River Spring Cave in Suwannee County (Streever 1993).

Phylum CHORDATA

Class OSTEICHTHYES

Family Anguillidae

Anguilla rostrata (Lesueur), American Eel (trogloxene). *Holmes County*: Vortex Blue Spring (Helfman 1986). *Jackson County*: Gerard's Cave (Pylka and Warren 1958, DSL), Hole-in-the-Wall (TM), Jackson Blue Spring (TM), Milton's Well Cave (DSL), Twin Cave (PS, TM). *Leon County*: Bird Sink (TM), Gopher Sink (Hobbs and Means 1972), Little Dismal (TM), Munson Slough Blue (TM), Sullivan's Sink (TM). *Madison County*: Thunderhole (TM). *Marion County*: Silver Glen Spring (Hobbs and Franz 1992). *Suwannee County*: Bonnett Spring (TM), Charles Spring (TM). *Wakulla County*: Wakulla Springs (TM).

Family Aphredoderidae

Aphredoderus sayanus (Gilliams), Pirate Perch (trogloxene). *Jackson County*: Ellis Cave (Brockman and Bortone 1977). *Suwannee County*: Irvine Slough Spring (TM), Orange Grove Sink (TM), Peacock Springs (TM). REMARKS: This fish has been seen up 200 m inside the cave at Peacock Springs and 16 m inside Irvine Slough Cave (TM).

Family Poeciliidae

Gambusia holbrooki Girard, Mosquitofish (trogloxene?). *Alachua County*: Twin Chimneys Sink (Marshall 1947). *Jackson County*: Pool Cave (DSL). *Leon County*: Gopher Sink (Hobbs and Means 1972). *Levy County*: Half-Moon Cave (Marshall 1947). REMARKS: Recent name change from *Gambusia affinis holbrooki.*

Family Moronidae

Morone saxitilus (Walbaum), Striped Bass (accidental). *Marion County*: Silver Glen Spring (Hobbs and Franz 1992). REMARKS: Specimens of this fish followed divers into the cave system at Silver Glen Springs (Hobbs and Franz 1992).

Family Cyrinidae

Notropis harperi Fowler, Redeye Chub (trogloxene). *Alachua County*: Bat Cave (Relyea and Sutton 1973*b*), Cow Sink (Marshall 1947), Fern Cave (TM), Hog Sink (Hobbs 1942*b*, Marshall 1947), Jerome Sink (Marshall 1947), Martin's Cave (Relyea and Sutton 1973*b*), Squirrel Chimney (TM), Zamia Sink (Marshall 1947). *Citrus County*: unidentified caves in Withlacoochee State Forest (DSL). *Gilchrist County*: Devil's Eye and Ear Spring (TM), Hart Spring (TM), Little Devil's Spring (TM), Otter Springs (TM). *Holmes County*: Vortex Spring (TM). *Jackson County*: Jackson Blue Spring (TM), Twin Cave (TM). *Leon County*: Gopher Sink (Hobbs and Means 1972), Half-Moon Cave (Marshall 1947), Pool Cave (O. G. Brock, personal communication, Florida Park Service). *Levy County*: Gunpowder Sink (TM). *Madison County*: Baseline Cave (TM), Thunderhole (TM). *Marion County*: Silver Glen Spring (Hobbs and Franz 1992). *Suwannee County*: Bonnett Spring (TM), Irvine Slough Cave (TM), Peacock Springs (TM), Wingate Well (TM). *Wakulla County*: Wakulla Springs (TM). *Washington County*: Econfina Blue Spring Cave (RF).

Family Ictaluridae

Ameiurus natalis (Lesueur), Yellow Bullhead (trogloxene). *Alachua County*: Bat Cave (RF, Relyea and Sutton 1973*b*), Chimney Sink (USNM), Crumbly Sink (TM), Hornsby Spring (TM), Martin Cave (Relyea and Sutton 1973*b*), Still Sink (Cooper 1965*b*). *Columbia County*: Jug Spring on Ichetucknee River (RF), Rose Creek Swallet and Overflow (TM). *Gilchrist County*: Devil's Eye and Ear Spring (TM), Hart Spring (TM), Otter Spring (TM), Siphon Creek Cave (TM), Rock Bluff Spring (TM). *Hamilton County*: Firecracker Cave (Pruitt 1991*d*, 1992), Pott Spring (TM), Rossiter Spring (TM), White Springs (all dead, TM). *Hernando*

County: Die Polder 3 (TM). Holmes County: Vortex Spring (TM). *Jackson County*: Hole in Wall (TM), Jackson Blue Spring (TM), Twin Cave (PS). *Lafayette County*: Alligator Rescue Spring (TM), Allens Mill Pond Spring (TM), Lafayette Blue Spring (Pruitt 1992), Perry Spring (TM). *Leon County*: Bird Sink Swallett (TM), Gopher Sink (TM), Munson Slough Blue (TM). *Levy County*: Manatee Springs (TM), Octopus Cave (Pruitt 1991*a*). *Madison County*: M2 Blue Cave (Pruitt 1991*d*, 1992). Thunderhole Sink (PH). *Suwannee County*: Anderson Spring (TM), Azure Blue (TM), Bonnett Springs (TM), Irvine Slough (TM), Peacock Springs (TM), Stick Sink (TM), Water Hole Cave (TM). *Wakulla County*: McBride Slough (TM), Wakulla Springs (TM). REMARKS. *Procambarus pallidus* was found in the stomach of a Chimney Sink catfish (notes associated with USNM crayfish specimen); *Procambarus lucifugus* in the stomach of Bat Cave catfish (Relyea and Sutton 1973*b*). Pruitt (1992) noted over a hundred individuals of this fish in Firecracker Cave in July.

Ameiurus nebulosus (Lesueur) Brown Bullhead (trogloxene?). *Hamilton County*: Firecracker Cave (Pruitt 1991*c*, 1992). *Holmes County*: Vortex Spring (TM).

Family Centrachidae

Lepomis macrochirus Rafinesque, Blue Gill (trogloxene). *Jackson County*: cave in Florida Caverns State Park (DSL), cave near dump south of Marianna (DSL).

Pomoxis nigromaculatus (Lesueur), Black Crappie (accidental). *Suwannee County*: Peacock III Spring (TM).

Class AMPHIBIA

Order CAUDATA

Family Ambystomatidae

Ambystoma opacum (Gravenhurst), Marbled Salamander (accidental). *Jackson County*: unidentified cave on Milton property (DSL).

Ambystoma tigrinum tigrinum (Green), Eastern Tiger Salamander (accidental). *Jackson County*: Milton's Well Cave (DSL).

Family Plethodontidae

Eurycea cirrigera (Green), Southern Two-lined Salamander (accidental). *Jackson County*: Ellis Cave (DSL).

Eurycea longicauda guttolineata (Holbrook), Three-lined Salamander (troglophile). *Jackson County*: Ellis Cave (DSL), Gerome's Cave (DSL), Miller's Cave (RF), Milton's Well Cave (DSL), Pottery

Cave (RF), Gerard's Cave (Lee 1969*c*). REMARKS: Larvae, transformed juveniles, and adults were present in several caves.

Plethodon grobmani Neill (trogloxene). *Jackson County*: Ellis Cave (DSL), Miller's Cave (RF), Milton's Well Cave (DSL), Pottery Cave (RF).

Order ANURA

Family Leptodactylidae

Eleutherodactylus planirostris planirostris (Cope), Greenhouse Frog (trogloxene). *Alachua County*: Bat Cave (RF). *Citrus County*: Sweet Gum Cave (RF). *Levy County*: Octopus Cave (Pruitt 1991*a*). *Marion County*: Orange Lake Cave (RF, DSL).

Family Bufonidae

Bufo terrestris Bonnaterre, Southern Toad (trogloxene). *Jackson County*: Milton's Well Cave (DSL).

Family Pelobatidae

Scaphiopus holbrooki holbrooki (Harlan), Eastern Spadefoot (accidental). *Alachua County*: Warren Cave (RF).

Family Hylidae

Acris gryllus dorsalis (Harlan), Florida Cricket Frog (accidental). *Jackson County*: Milton's Well Cave (DSL).

Pseudacris crucifer crucifer Weid, Northern Spring Peeper (accidental). *Jackson County*: Milton's Well Cave (DSL).

Hyla gratiosa Leconte, Barking Tree Frog (accidental). *Jackson County*: Milton's Well Cave (DSL), Miller's Cave (RF).

Hyla squirella Sonnini and Latreille, Squirrel Treefrog (accidental). *Jackson County*: Milton's Well Cave (DSL).

Family Ranidae

Rana catesbeiana Shaw, Bullfrog (accidental?). *Alachua County*: Bat Cave (RF), Goat Sink (Lee 1969*c*). *Jackson County*: Gerome's Cave (DSL), Ellis Cave (RF), Gerard's Cave (Lee 1969*c*). *Suwannee County*: Sim's Sink (RF). REMARKS: Large female bullfrog (173 mm SVL) from Gerome's Cave contained an unidentified bat in its stomach (DSL).

Rana clamitans Latreille, Bronze Frog (accidental). *Jackson County*: Milton's Well Cave (DSL).

Rana grylio, Pig Frog (accidental). *Levy County*: Octopus Cave (Pruitt 1991*a*).

Rana utricularia Cope, Southern Leopard Frog (accidental?). *Alachua County*: Bat Cave (RF), Warren Cave (Hobbs 1942*b*). *Columbia County*: Riverbed Cave (Hobbs 1942*b*). *Jackson County*: Gerard's Cave (Lee 1969*c*), Waddell's Mill Spring Cave (DSL). *Levy County*: Octopus Cave (Pruitt 1991*a*). *Marion County*: Orange Lake Cave (RF, DSL), Sunday Sink (RF).

Class REPTILIA
Order CROCODYLIA
Family Alligatoridae

Alligator mississipiensis (Daudin), American Alligator (accidental). *Jackson County*: Small cave along the Chipola River floodplain (RF). *Lafayette County*: Alligator Rescue Spring (TM). *Levy County*: Maddox Cave (BP, BH, AK). REMARKS: A small alligator (approx. 1 m in length) was wedged into the passage of a small cave at the base of a limestone bluff along the floodplain of the Chipola River. A 2-m individual repeatedly was found in Maddox Cave about 15 m inside the entrance. The Lafayette animal was rescued from the bottom of a collapse sink where it had apparently fallen and became entrapped. Other alligators are reported from caves in the vicinity of Sawgrass Lake, southeast of Archer, Levy County, Florida (A. Krause, personal communication).

Order TESTUDINES
Family Chelydridae

Chelydra serpentina osceola Stejneger, Florida Snapping Turtle (accidental). *Marion County*: Nickelberger Cave (PS).

Family Emydidae

Pseudemys floridana peninsularis Carr, Peninsula Cooter (accidental). *Citrus County*: Hall's Bat Cave (DSL). REMARKS: Unidentified *Pseudemys* also are reported from Octopus Cave, Levy County (Pruitt 1991*a*).

Order SQUAMATA
Suborder LACERTIDAE
Family Anguidae

Ophisaurus ventralis (Linnaeus), Eastern Glass Lizard (accidental). *Jackson County*: Milton's Well Cave (RF).

Suborder SERPENTES
Family Colubridae

Nerodia fasciata fasciata (Linnaeus), Banded Watersnake (accidental). *Jackson County*: Pool Cave (RF).

Elaphe guttata guttata (Linnaeus), Corn Snake (trogloxene). Listed only as Florida caves by Pylka (1957).

Elaphe obsoleta quadrivittata (Holbrook), Yellow Ratsnake (trogloxene). *Alachua County*: Bat Cave (RF). *Citrus County*: Sweet Gum Cave (Hobbs 1942*b*, RF).

Elaphe obsoleta spiloides (Dumeril, Bibron, Dumeril), Gray Ratsnake (trogloxene). *Jackson County*: Geromes Cave (RF, DSL), Gerard's Cave (Lee 1969*c*).

Family Viperidae

Agkistrodon piscivorous conanti Gloyd, Florida Cottonmouth (accidental?). *Jackson County*: Ellis Cave (DSL), Judges Cave (DSL).

Crotalus adamanteus Beauvois, Eastern Diamondback Rattlesnake (accidental). *Alachua County*: Squirrel Chimney (Franz 1968).

Class AVES

Family Strigidae

Strix varia alleni Ridgway, Barred Owl (accidental?). *Levy County*: Octopus Cave (Pruitt 1991*a*).

Family Cathartidae

Coragyps atratus (Bechstein), Black Vulture (accidental?, nesting in cave). *Jackson County*: Unnamed cave on Merritt's Mill Pond. REMARKS: Adult and two young were found 7 m inside the cave entrance (TM).

Class MAMMALIA

Family Didelphidae

Didelphus virginana pigra Bangs, Virginia Opossum (accidental). Listed only as Florida caves by Pylka (1957).

Family Soricidae

Blarina carolinensis carolinensis (Bachman), Short-tailed Shrew (accidental). *Levy County*: Octopus Cave (Pruitt 1991*a*).

Family Molossidae

Tadarida brasiliensis cynocephala (LeConte), Freetail Bat (accidental). *Marion County*: "several caves" (Morgan 1985). REMARKS: Record based on single observations at Orange Lake Cave and Sunday Sink in September 1974 and 1975, respectively. In each case, single bats (males?) were found on the walls at night near the cave entrances. The bats immediately took flight and left the cave when they were disturbed (RF field notes).

Family Vespertilionidae

Pipistrellis subflavus floridanus Davis, Least Bat (trogloxene). *Alachua County*: Goat Sink (RF). *Gilchrist County*: Roberts Cave (RF). *Levy County*: Octopus Cave (Pruitt 1991*a*). *Jackson County*: Gerome's Cave (DSL), Miller's Cave (Brock, personal communication), Old Indian Cave (Rice 1955*a*, 1955*b*, Jennings and Layne 1957), Gerard's Cave (Lee 1969*c*). *Marion County*: Orange Lake Cave (RF), Sunday Sink (RF).

Myotis austroriparious (Rhoads), Southeastern Bat (trogloxene). *Alachua County*: Bat Cave (RF), Grant's Cave (RF, Rice 1957), Hog Sink (Rice 1957), Jones Cave (McNab 1974), Seven Chimneys Sink (McNab 1974), Warren Cave (McNab 1974). *Citrus County*: Sweet Gum Cave (RF). *Gilchrist County*: Roberts Cave (RF, Rice 1957). *Jackson County*: Gerard's Cave (DSL), Old Indian Cave (Jennings and Layne 1957), Mud Cave (Rice 1955*b*). *Levy County*: Devil's Den (Pruitt 1991*b*), Octopus Cave (Pruitt 1991*a*). *Marion County*: Hell Hole (BH), Orange Lake Cave (RF), Sunday Sink (RF). *Suwannee County*: Devil's Head and Horns, Mulky Road Sink (RF). (Also see Humphrey and Gore 1992). REMARKS: This bat is proposed a candidate for federal listing (Wood 1993)

Myotis grisescens Howell, Gray Bat (trogloxene). *Jackson County*: Gerome's Cave (DSL), Gerard's Cave (DSL), Milton's Cave (DSL), Old Indian Cave (Rice 1955*b*, Jennings and Layne 1957, Lee and Tuttle 1970, Humphrey and Tuttle 1978), ONS Cave (DSL). REMARKS: The Florida Committee on Rare and Endangered Plants and Animals listed this bat as Endangered (Humphrey and Tuttle 1978; Gore 1992). This bat also is listed by both the State of Florida and by U. S. Fish and Wildlife Service as Endangered (Wood 1993).

Myotis keenii septentrionalis (Trouessart), Keen's Bat (trogloxene). *Jackson County*: Old Indian Cave (Rice 1955*b*, Scudder and Humphrey 1978). REMARKS: Only two specimens of this bat are known from Florida. This bat was considered Endangered in the 1982 Florida Rare and Endangered Biota volume on mammals (Scudder and Humphrey 1978) but not listed in the 1992 revised volume (Humphrey 1992).

Myotis sodalis Miller and Allen, Social Bat (trogloxene). *Jackson County*: Old Indian Cave (Jennings and Layne 1957, Humphrey and Scudder 1978). Only one specimen is known from Florida. The Florida Committee on Rare and Endangered Plants and Animals listed this bat as Endangered (Humphrey and Scudder 1978; Humphrey 1992). This bat also is listed by the State of Florida and the U.S. Fish and Wildlife Service as Endangered (Wood 1993).

Family Castoridae

Castor canadensis carolinensis Rhoads, Beaver (accidental). *Jackson County*: Gerome's Cave (DSL).

Family Sciuridae

Sciurus carolinensis carolinensis Gmelin, Gray Squirrel (accidental). Listed only as Florida caves by Pylka (1957).

Family Cricetidae

Peromyscus gossypinus gossypinus (Leconte), Cotton Mouse (accidental). *Levy County*: Octopus Cave. *Jackson County*: Gerome's Cave (DSL), Gerard's Cave (Lee 1969*c*).

Neotoma floridana floridana (Ord), Eastern Woodrat (trogloxene). *Columbia County*: Bussey's Sink (RF). *Jackson County*: Gerome's Cave (DSL), Old Indian Cave (DSL), Pool Cave (DSL), Waddell's Mill Pond Cave (DSL), Gerard's Cave (Lee 1969*c*). *Marion County*: Sunday Sink (RF). *Suwannee County*: Mulky Road Sink (RF).

Family Procyonidae

Procyon lotor elucus Bangs, Raccoon (accidental?). *Levy County*: Octopus Cave (Pruitt 1991*a*).

SUMMARY—The less specialized members of the Florida and south Georgia cave faunas include: unidentified zooplankton, sponges, one colonial cnidarian, two branchiobdellid annelids, unidentified aeolosomatid oligocheates, two bivalves, five prosobranch and nine pulmonata gastropods, four entocytherid and several other ostracods, unidentified copepods, one isopod, two amphipods, eight decapods (shrimps, crayfishes, and crab), two springtails, three crickets, nine beetles, two parasitic flies, one vinegaroon, two harvestmen, five spiders, unidentified mites, one millipede, one centipede, nine fishes, five salamanders, 11 frogs, one crocodilian, two turtles, one lizard, six snakes, two birds, and 13 mammals. The list consists of 37 accidentals, 47 trogloxenes, 23 troglophiles, and four obligate commensals on troglobite hosts. Of the vertebrates, a few fishes (*Anguilla rostrata, Notropis harperi, Ameiurus natalis*), one salamander (*Eurycea longicauda*), two frogs (*Rana catesbeiana, R. utricularia*, and five bats (*Pipistrellis subflavus, Myotis austroriparius, M. grisescens, M. keeni*, and *M. sodalis*) appear to have more than a casual relationship with Florida caves. *Myotis grisescens, M. keeni*, and *M. sodalis* are the only

bat species recorded from Florida that are dependent on caves; the latter two are reported only rarely and probably are not regular members of Florida and south Georgia's cave faunas.

OBLIGATE CAVE FAUNAS AND KARST REGIONS

The biogeography of Florida and south Georgia's troglobites have been discussed by Hobbs (1958), Caine (1974), Relyea et al. (1976), Hobbs et al. 1977, Means (1977), Franz and Lee (1982), and others. Each new discovery invites interpretative changes. The new distributional records accumulated since 1982 necessitate further comments concerning distributional patterns exhibited by this unique group of species.

Six distinct cave faunas are suggested in the Florida and south Georgia region (Fig. 2). Other unidentified faunas may emerge when limestone areas outside of the geographic ranges of the six are better surveyed. Each of the six faunas occupies a specific geographic range, has precinctive taxa, and is characterized by specific geologic and hydrologic characteristics. The two largest faunas (Ocala, St. Johns) are broken into smaller assemblages (Table 1, Fig. 3). An assemblage is defined as an isolated segment of a fauna that possesses distinctive taxa.

Taxa are listed for each fauna in the accompanying faunal descriptions; taxa associated with a specific assemblage are shown on Table 1. In these faunal descriptions, one asterisk (*) preceding a name indicates a precinctive species; double asterisks (**) identify taxa that occur in three or more faunas.

Econfina Creek Fauna

Species List—**Dasyscias franzi*, **Caecidotea* sp.1. The fauna is known from a single cave in the Econfina Creek basin. The karst area associated with the Econfina Creek Fauna is located in southern Washington and northern Bay counties. It remains largely unexplored, although there are numerous spring outlets along the mid-portions of Econfina Creek where elements of the fauna may eventually be found. Additional spring water also emerges from the Floridan aquifer directly into Econfina Creek through fissures in the stream bed and from the base of bluffs at points where the stream breaches overlying terrace deposits (Vernon 1942, Musgrove et al. 1965). Econfina Blue Springs are composed of several spring outlets along the edge of a low bluff that borders a large spring pool on the east side of Econfina Creek. Combined flow rates for these springs ranged from 32-51 cu. ft/sec. (1941-1972) (Rosenau et al. 1977). The springs are developed at the contact between an upper

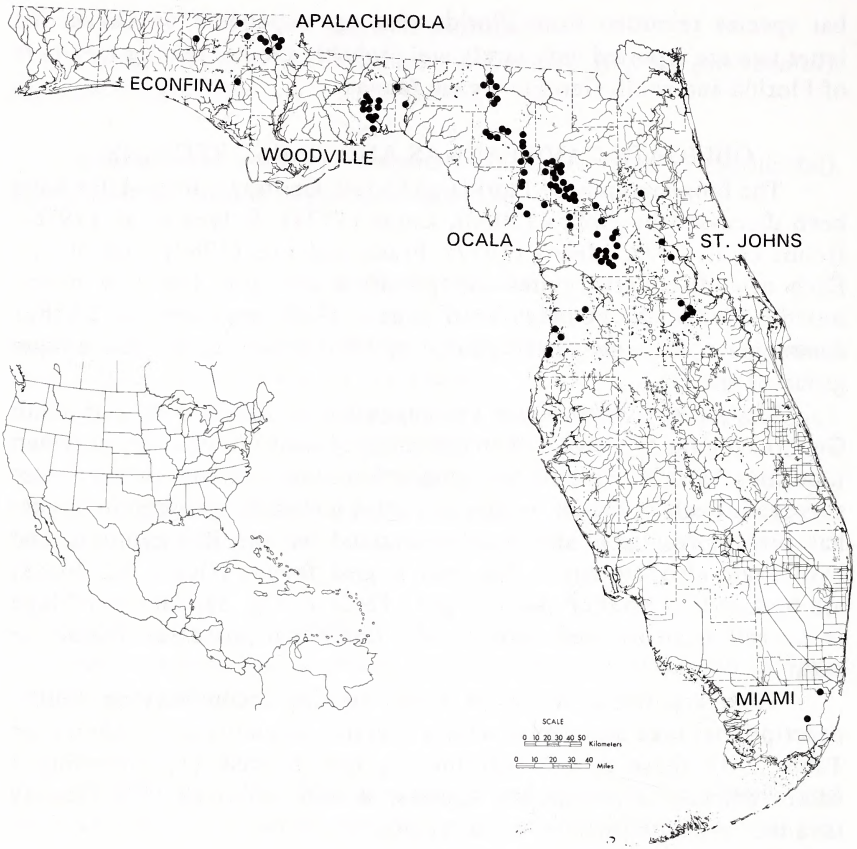

Fig. 2. Distributions of the six regional faunas. Dots indicate the position of biologically significant caves in Florida (see Appendix 1).

shell bed and a fine- to medium-grained dolomitic calcarenite that appears to be related to the Jackson Bluff group of marine sediments, probably Miocene in age (Muriel Hunter, personal communication, Tallahassee, Florida). Cooke (1945) considered the shell layer to represent the "Cancellaria Zone" in the Duplin marl which overlies a "cavernous limestone" in the Shoal River Formation. These spring caves lie close enough to the surface that they are breached by numerous small conical sinks in the adjoining upland. Available samples of the Econfina Creek Fauna were obtained from a small, permanently flowing cave stream at the base of one of these sinkholes behind the most westerly spring outlet.

Fig. 3. Distribution of the assemblages associated with the Ocala Fauna.

Apalachicola Fauna.

Species List—***Caecidotea hobbsi*, **Cambarus cryptodytes*, *Pseudosinella pecki*, **Islandiana* sp., **Haideotriton wallacei*. Three of five taxa associated with the Apalachicola Fauna are precinctive. This faunal region contains the only known terrestrial troglobites in the state. The Apalachicola Fauna occurs in two segments, one in the Marianna Lowlands of Jackson County, Florida, and the other in the Dougherty Plain along the Flint River in Decatur and Dougherty counties, Georgia (Fig. 4) (Beck and Arden 1984, Lane 1989). Franz and Lee (1982) suggested that the Marianna species were associated with caves that were developed in the Ocala Group limestones at or near the

Table 1. Species composition of the assemblages associated with the Ocala and St. Johns River cave faunas. Asterisk (*) identifies unique taxa in each assemblage.

OCALA FAUNA

Upper Suwannee Assemblage.
- *Caecidotea hobbsi*
- *Remasellus parvus*
- *Crangonyx grandimanus*
- *Crangonyx hobbsi*
- **Palaemonetes cummingi*
- **Procambarus erythrops*
- **Procambarus lucifugus alachua*
- **Procambarus pallidus*
- *Troglocambarus maclanei*

Lower Suwannee Assemblage
- *Crangonyx grandimanus*
- *Crangonyx hobbsi*
- **Procambarus lucifugus* X *alachua*
- *Troglocambarus maclanei*

Orange Lake Assemblage
- *Crangonyx hobbsi*
- **Procambarus franzi*
- *Troglocambarus maclanei*

Marion Assemblage
- *Caecidotea hobbsi*
- *Crangonyx grandimanus*
- *Crangonyx hobbsi*
- **Procambarus lucifugus* X *alachua*
- *Troglocambarus maclanei*

Withlacoochee Assemblage
- *Crangonyx hobbsi*
- **Procambarus lucifugus lucifugus*
- *Troglocambarus maclanei*

Gulf Coastal Lowlands Assemblage
- *Crangonyx grandimanus*
- *Crangonyx hobbsi*
- **Procambarus leitheuseri*
- *Troglocambarus maclanei*

ST. JOHNS RIVER FAUNA

Wekiwa Assemblage
- **Caecidotea* sp. 2
- **Procambarus acherontis*
- **Troglocambarus* sp.

Lake George Assemblage
- **Procambarus attiguus*
- **Procambarus delicatus*
- **Procambarus morrisi*

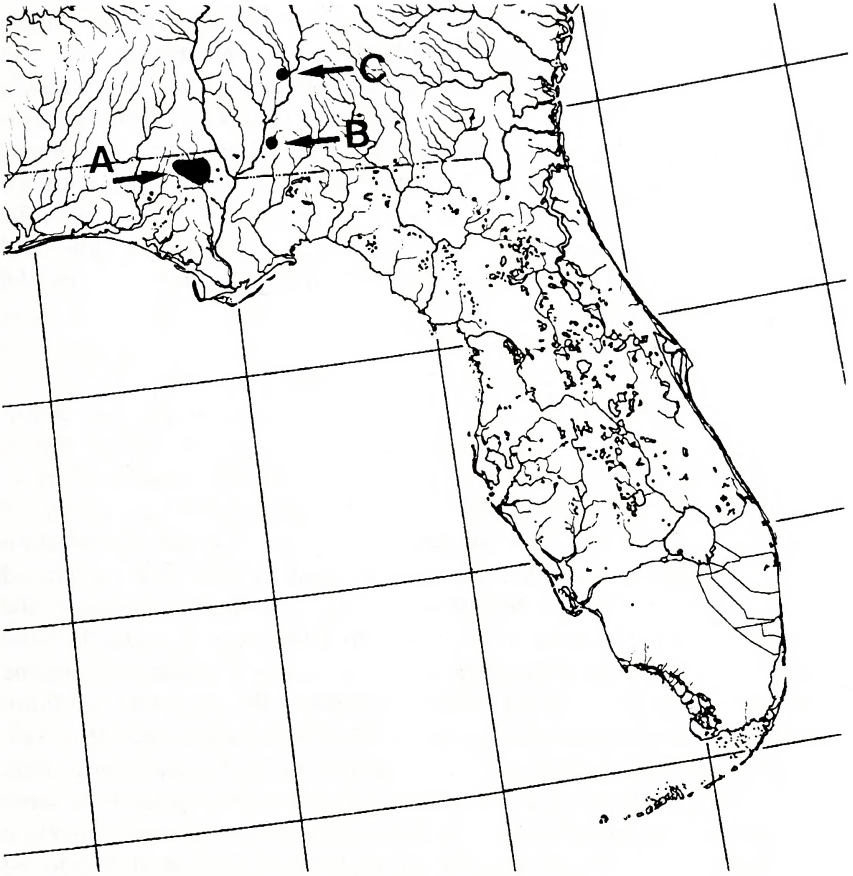

Fig. 4. Caves associated with the (A) Marianna Lowlands and Southwest Georgia segments of the Apalachicola Fauna. Georgia sites—(B) Climax Cave and (C) Albany well.

contact with the younger Suwannee and Marianna limestones (Floridan aquifer). The troglobite records from southwest Georgia were taken from a well at Albany in the heart of the Dougherty Plain and in cave pools at Climax Cave near Climax, Georgia. Climax Cave lies at base of the Pelham Escarpment of the Tipton Upland on the eastern edge of the Dougherty Plain (Beck and Arden 1984). Like caves in the Marianna area, Climax Cave is developed near the contact between the Suwannee Limestone and the Ocala Group limestones (Floridan aquifer) (See Fig. 12b in Beck and Arden 1984).

Means (1977) felt that the two segments were continuous and that the aquatic troglobites could disperse between the two areas wherever

there were solution channels in the limestone large enough to accommodate them. Unfortunately, there are no records of these species from intermediate areas, although Means (1977) noted a cave along the Apalachicola River that should be sampled. No troglobites were located during preliminary surveys of caves in Dothan County, Alabama (John E. Cooper, personal communication, Raleigh, North Carolina). Slight or no morphological differences have been noted between the populations of *Cambarus cryptodytes* and *Haideotriton wallacei* from the two areas (Pylka and Warren 1958, Means 1977, Hobbs 1981), which further supports the continuous population hypothesis.

Woodville Fauna

Species List—*Remasellus parvus*, ***Crangonyx hobbsi*, ***Crangonyx grandimanus*, **Procambarus horsti*, **P. orcinus*.The Woodville Fauna is associated with the Ocala Group limestones (Floridan aquifer) in the eroded portions of the Tallahassee Hills and the Woodville Karst Plain, along and below the Cody Scarp, respectively. It is bounded on the west by the Apalachicola Coastal Lowlands (see Hendry and Sproul 1966). The eastern limits remain to be defined, although none of the fauna is known to occur east of the Aucilla drainage. Hendry and Sproul (1966) and Yon (1966) show a more or less continuous limestone shelf below the Cody Scarp (Woodville Karst Plain) across southern Leon and Jefferson counties. Lane (1986:32) describes this area as a "flat to gently undulating surface of sand that overlies carbonate rock. The carbonates, which lie at shallow depths of 30 feet or less, have undergone extensive solution by groundwater. This plain exhibits karst features that are still evolving, for example: many old, well developed sinkholes that are either permanently or intermittently flooded (Big Dismal Sink), disappearing streams and natural bridges (Natural Bridge), Wakulla Springs, and new sinkholes reported periodically."

The fauna appears to follow the riverine karsts associated with the Wakulla-St. Marks rivers and the Wacissa River. In this way, the endemic crayfishes parallel the distribution of the closely-related *Procambarus pallidus* that tracks the riverine karsts of the upper Suwannee River and its tributaries. *P. orcinus* may be restricted to the Wakulla drainage, whereas *P. horsti* may be more closely-tied to the St. Marks and Wacissa drainages. The ecological relationships between them remain unclear, particularly in lieu of an account that both crayfishes co-exist in the Wakulla Springs Cave System (Morris 1989). More collecting is necessary in caves of the Woodville Karst Plain to determine the actual geographic extent of this fauna and its ecological specializations.

Ocala Fauna

Species List—****Caecidotea hobbsi*, *Remasellus parvus*, ***Crangonyx grandimanus*, ***C. hobbsi*, **Palaemonetes cummingi*, **Procambarus erythrops*, **P. franzi*, **P. leitheuseri*, **P. lucifugus lucifugus*, **P. lucifugus alachua*, **P. lucifugus* X *alachua*, **P. pallidus*, **Troglocambarus maclanei*. The Ocala Fauna occurs in mature and riverine karst areas associated with Ocala Group limestones (Floridan aquifer), from the Suwannee River drainage, southwest through Alachua, Marion, Levy, Citrus, Hernando, Pasco, and possibly Pinellas counties. Within this region, the fauna appears fragmented into a series of six geographically distinct assemblages, each characterized by endemic taxa (Table 1). The factor that consolidates the Ocala Fauna is the presence of the crayfishes *Procambarus lucifugus* (and allied species) and *Troglocambarus maclanei* which are represented in every Ocala assemblage.

The Upper Suwannee appears to be the most distinctive of the six assemblages. The Upper Suwannee incorporates the riverine karsts along the upper Suwannee, (northern) Withlacoochee, and lower Santa Fe rivers. It also spills over through the High Springs Gap onto the Western Valley (=Newberry Karst Plain) between the Cody Scarp and the (northern) Brooksville Ridge in western Alachua and northeastern Levy counties (see Fig. 4 and discussions by White 1970, Hoenstine and Lane 1991). In the Western Valley, the assemblage tracks what appears to be an ancient stream channel that may have been a former surface tributary of the Santa Fe River. The Lower Suwannee Assemblage is centered in a small karst area between the town of Bell in Gilchrist County and the Chiefland-Manatee Springs area in Levy County, west of Bell Ridge and the Waccasassa Flats. The Upper and Lower Suwannee assemblages are each distinctive: *Palaemonetes cummingi*, *Procambarus lucifugus alachua*, and *P. pallidus* in the Upper Suwannee; *Procambarus lucifugus* X *alachua*, in the Lower Suwannee. The Upper Suwannee includes populations of the isopod *Remasellus parvus* that also occurs in the Wakulla area south of Tallahassee, but yet unrecorded from the Lower Suwannee. The Upper Suwannee Assemblage (notably *Procambarus pallidus*) ranges down the Suwannee River as far south as Rock Bluff Spring, but apparently does not occur in the Bell karst. For unknown reasons there are no troglobites known from limestone areas on the other bank of the Suwannee River in Dixie County. Barriers to dispersal, if any exist, that separate the Upper and Lower Suwannee assemblages have not been identified.

The Orange Lake and Marion assemblages lie in karsts of Marion County. The Orange Lake Assemblage, which includes the endemic

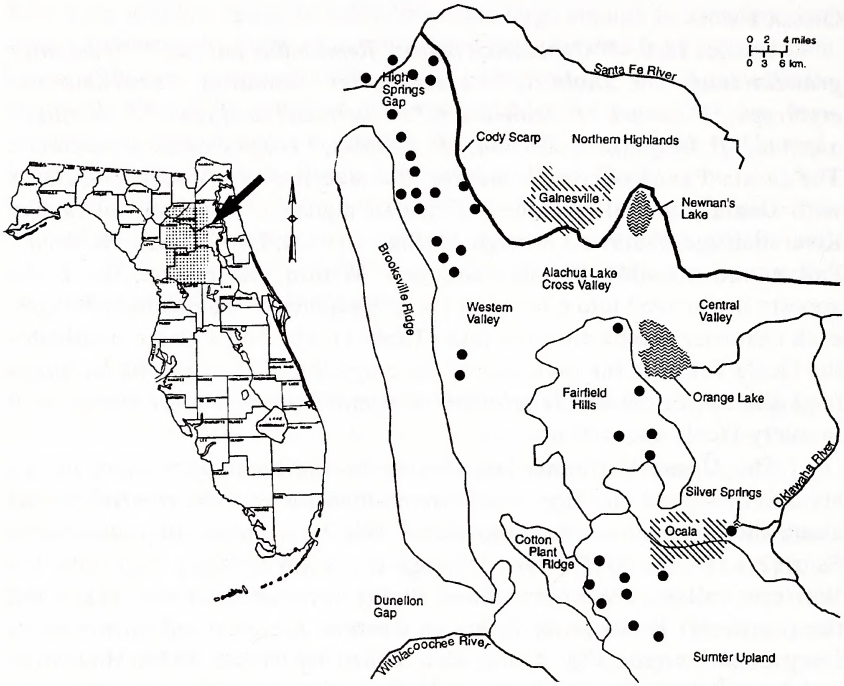

Fig. 5. Map showing important physiographic units that might influence the distributions of species of the Upper Suwannee, Orange Lake, and Marion assemblages in Alachua and Marion counties.

Procambarus franzi, is associated with the eastern Fairfield Hills, south of Orange Lake, whereas the Marion Assemblage occurs in a southern extension of the Western Valley, the Sumter Upland, and the Oklawaha portion of the Central Valley (at Silver Springs) (Fig. 5). Like the Lower Suwannee, the Marion Assemblage includes an intergrade population of *Procambarus lucifugus*.

Hydrologically, the Orange Lake and Marion assemblages fall within the Oklawaha River Drainage Basin as defined by Faulkner (1973) and Lane and Hoenstine (1991). The Fairfield Hills area represents the extreme northwestern corner of the Silver Springs Drainage Area, which has its outlet at Silver Springs on the Oklawaha River in the Central Valley. The Marion Assemblage occurs both in the Silver Springs Drainage Area (at Silver Springs on the Oklawaha River) and the Rainbow Springs Drainage Area with its primary outlet through Rainbow Springs on the (southern) Withlacoochee River (Lane and Hoenstine 1991).

The Withlacoochee Assemblage definitely is known from only one locality (Sweet Gum Cave) on the east slope of the (southern) Brooksville Ridge. A second record (cave 23.3 km north of Weekiwachee) was listed in Hobbs (1942*b*) from Hernando County, but its specific location remains unknown. The unique *Procambarus lucifugus lucifugus* is reported from both sites. The directions listed with the Hernando specimens, if taken literally, places the locality near the Citrus-Hernando county line, probably near Chassahowitzka in Citrus County, on the west side of the (southern) Brooksville Ridge. This area has low relief, and any cave would be flooded and would likely function as a spring, such as the Chassahowitzka Springs group near the town with the same name (see Rosenau et al. 1977). However, if the collector's directions were slightly off and the cave was actually northeast of Weekiwachee, then the locality would fall on the eastern side of the Brooksville Ridge, within 6 km of Sweet Gum Cave. More effort is needed to locate appropriate caves along the (southern) Brooksville Ridge, particularly in the vicinity of the Citrus-Hernando county line, to resolve the Withlacoochee Assemblage's actual geographic extent.

The final assemblage occurs in the Gulf Coastal Lowlands in southwestern Hernando and northwestern Pasco counties. The area lies on the west side of the (southern) Brooksville Ridge, between the towns of Weekiwachee and Hudson. A sighting of a small *Troglocambarus*-like crayfish in Knights Sink at Lake Tarpon suggests that this assemblage's geographic range actually might extend as far south as northern Pinellas County. It includes the unique *Procambarus leitheuseri*. All of the known localities occur in a small coastal limestone strip subdued in part by marine terrace deposits, between the 0.6-m (2 ft) and 9.1-m (30 ft) contour lines (Wetterhall 1965). Troglobites in this assemblage have been recovered from several deep sinks and springs associated with the ridge terrace (Die Polders) and from a spring (Black Hole) in a coastal salt marsh.

St. Johns River Fauna

Species List—**Caecidotea* sp. 2, **Procambarus acherontis*, **P. attiguus*, **P. delicatus*, **P. morrisi*, **Troglocambarus* sp. The St. Johns River Fauna is still incompletely known, and more new taxa are expected as divers penetrate unexplored karst windows and springs along the St. Johns and lower Oklawaha rivers. There are two related assemblages of troglobites within this fauna, one focusing on a small karst area along the Wekiva River in the Orlando metropolitan area and the other occurring along the west shore of Lake George, Alexander Spring Run, and the lower Oklawaha River. No species have been found in the

30-km stretch between the two areas. All of the known occurrences of this fauna are in flooded caves associated with springs, sinkholes, and wells. These cave systems are developed near the contact between the basal units of the Hawthorne Formation and the underlying Ocala Group limestones (Floridan aquifer) (Hobbs and Franz 1986, 1990, 1992).

The Wekiva Assemblage includes an undescribed isopod (*Caecidotea* sp. 2), *Procambarus acherontis*, and an unstudied population of *Troglocambarus*. It occurs in a small limestone plain that lies along the Wekiva River, and east of the Lake Apopka basin, in western Orange and Seminole counties. Groundwater originates in a sand hill region south of the sinkhole plain. A north-directed branch of this water flows northeast towards the Wekiva valley, but an eastern branch intersects a "bad water zone" in eastern Orange County that contains dissolved solids in excess of 1,800 ppm (Barraclough 1962, Lichtler et al. 1968). The north branch emerges as springs along the south escarpment of the river (Rock, Wekiwa, Palm, Sanlando, Witherington, and Barrel springs). Analysis of water from these springs shows less than 150 ppm of dissolved solids, and several, such as Palm Springs, have the odor and white slimy bacteria that are associated with sulphur springs.

The Lake George Assemblage remains poorly known. Three crayfishes are known: *Procambarus attiguus*, *P. delicatus*, and *P. morrisi*. The first two belong to the *seminolae* group and probably are related to *Troglocambarus*, whereas *Procambarus morrisi* is related to *P. acherontis*. Riverine karsts extend north of the Lake George springs area to at least Green Cove Springs in Clay County. Divers that penetrated the spring at Green Cove reported no troglobites (WS), although more effort is necessary, possibly using baited traps, to verify their observations. More exploration in the riverine karsts along the Oklawaha River should be encouraged. The presence of *Procambarus attiguus* at Devils Sink in Putnam County and *Procambarus lucifugus* and sightings of isopods and amphipods in Silver Springs suggest a region with a complex biota.

Miami Fauna

Species List—****Crangonyx grandimanus*, ***C. hobbsi*, **Procambarus milleri*. The Miami Fauna was collected from shallow wells at the Little Bird Nursery and Garden Store in Miami (Hobbs 1971) and in northeast Homestead (HHH, personal communication). The latter site is approximately 22 km southwest of the type locality (W. Loftus, personal communication). According to Hobbs (1971), the original specimens from the type locality were obtained from a trap at the outlet of a motorized pump associated with the Little Bird well in 1968. Both

sites are associated with the Miami oolite. Parker and Cook (1944) indicated that since so much of the Miami oolite is occupied by solution holes it is highly permeable in a vertical direction and is a good aquifer that furnishes supplies to many small wells. However, they report it to have a low horizontal permeability which theoretically might restrict the dispersal of larger troglobites. This fauna is currently known from only two sites, and it should be searched for elsewhere in suitable groundwater habitats in Dade County. The Miami Fauna is associated with the Biscayne aquifer, unlike cave faunas in north Florida and south Georgia that occur in the Floridan aquifer.

FAUNAL RELATIONSHIPS

Cave crayfishes are the best indicators of faunal relationships because the other Florida troglobites either have very limited distributions or range over at least three faunal areas. Troglobitic crayfishes are found in all but the Econfina Creek Fauna.

Six crayfish lineages are involved: (1) *Cambarus* (subgenus *Jugicambarus*) represented by *Cambarus cryptodytes* restricted to the Apalachicola Fauna; (2) *Procambarus* (subgenus *Leconticambarus*), by *Procambarus milleri*, Miami Fauna; (3) *Procambarus* (subgenus *Lonnbergius*), by *Procambarus acherontis* and *P. morrisi*, St. Johns River Fauna; (4) *Procambarus* (subgenus *Ortmannicus*, Pictus Group, *lucifugus* complex), by *Procambarus erythrops*, *P. franzi*, *P. leitheuseri*, *P. lucifugus lucifugus*, *P. lucifugus alachua*, *P. lucifugus* intergrade populations, Ocala Fauna; (5) *Procambarus* (subgenus *Ortmannicus*, Pictus Group, *pallidus* complex), by *Procambarus horsti*, *P. orcinus*, *P. pallidus*, Woodville and Ocala faunas; and (6) *Procambarus* (subgenus *Ortmannicus*, Seminolae Group) and *Troglocambarus*, by *Procambarus attiguus*, *P. delicatus*, *Troglocambarus maclanei*, and *Troglocambarus* sp., St. Johns River and Ocala faunas.

Lineages 1-4—The first four lineages have restricted distributions and therefore provide little information concerning the relationships between faunal groups.

Lineage 5—The *pallidus* complex occurs in both the Woodville Fauna and the Upper Suwannee Assemblage of the Ocala Fauna. As a group, they are thought to have had a common ancestor, one similar in morphology to the extant *Procambarus leptodactylus*, which now occurs in streams north of Florida (Hobbs 1958, Franz and Lee 1982, Hobbs and Franz 1986). The distribution of the *pallidus* complex corresponds to the western slope of the old Northern Highlands described by White (1970) and is associated with Eocene limestone areas along the Cody Scarp (Fig. 6). Troglobites have not been found in the intervening

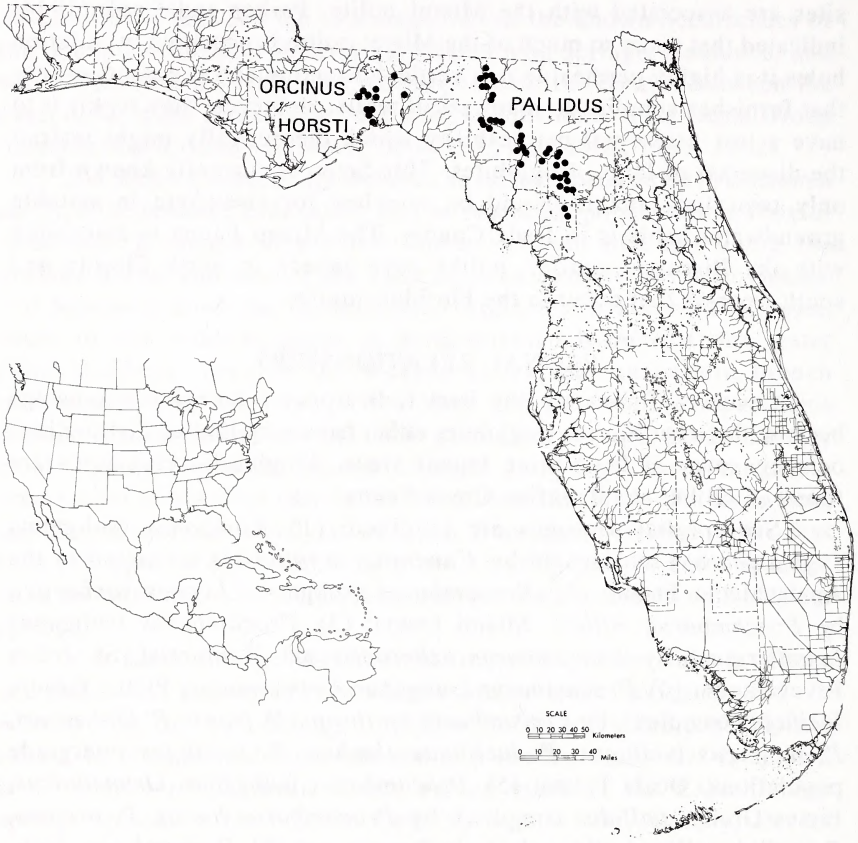

Fig. 6. Distribution of *Procambarus horsti*, *Procambarus orcinus*, and *Procambarus pallidus*.

area that separates the two faunas, although more exploration in the 50-km-wide hiatus may change this view. We suggest that the evolutionary history of the *pallidus* complex involved independent invasions of ancestral *leptodactylus*-like stocks into geographically isolated groundwater reservoirs associated with the Cody Scarp in the Woodville and Upper Suwannee areas. Subsequent evolution led to the differentiation of the *horstiorcinus* branch in the St. Marks-Wakulla-Wacissa drainages and the *pallidus* branch in the Suwannee basin.

Lineage 6—Hobbs (1942) and Hobbs and Franz (1986) pointed out the similarities between *Troglocambarus maclanei* and members of the Seminolae Group in the genus *Procambarus*. They felt that these features indicated a evolutionary relationship between the two

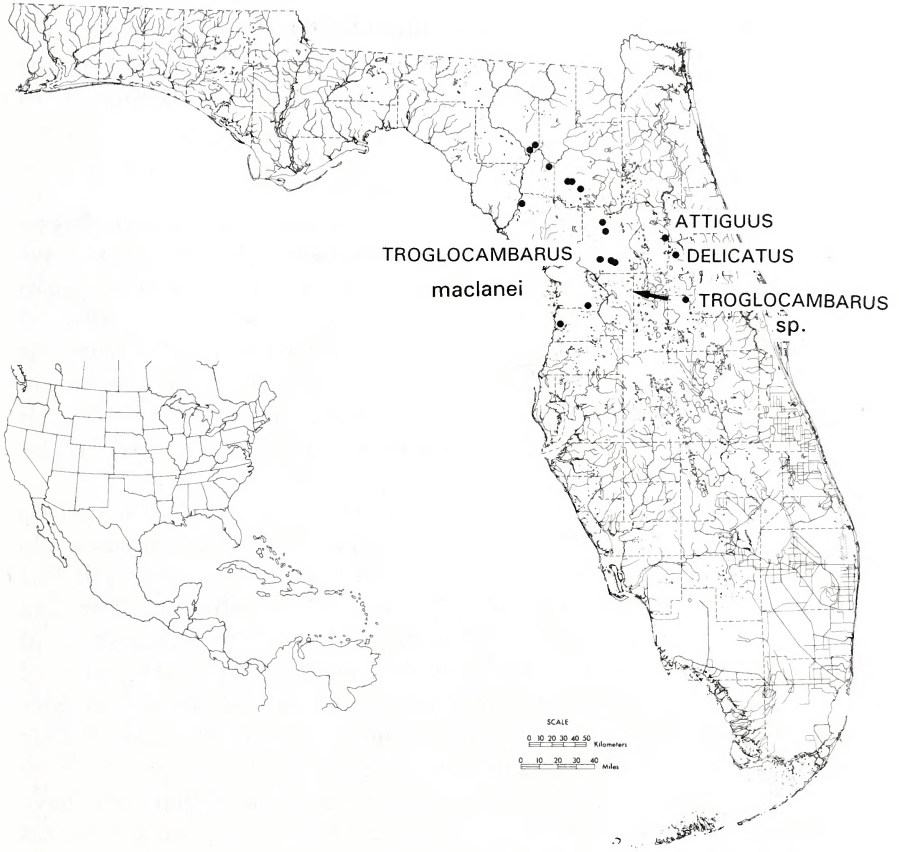

Fig. 7. Distribution of *Procambarus attiguus*, *Procambarus delicatus*, *Troglocambarus* sp., and *Troglocambarus maclanei*. Arrow shows the suggested direction for the dispersal of *Troglocambarus* lineage.

groups of crayfishes. The recent discoveries of two troglobitic members of the Seminole Group (*Procambarus attiguus* and *P. delicatus*) and an unstudied population of *Troglocambarus* in the St. Johns River basin (Fig. 7) allows for further speculation concerning the evolution of this lineage. We propose that the initial differentiation of *Troglocambarus* from ancestral *Procambarus* stocks occurred in karsts associated with the St. Johns River. Then, one branch of *Troglocambarus* dispersed from the St. Johns River karst area, via subterranean routes, into cave systems on the western slope of the Northern Highland (Fig. 7). They probably arrived on the western slope already preadapted for co-existence with larger, less specialized cave *Procambarus* (lineages 4 and 5). Unfortunately, the absence of Form I males for the Orlando

Troglocambarus prevents a more scholarly interpretation of the relationships between the St. Johns and Ocala populations of *Troglocambarus* and between the Orlando *Troglocambarus* and *Procambarus attiguus* and *P. delicatus*.

CONSERVATION

Troglobitic populations of most Florida and south Georgia faunas are potentially susceptible to human disturbance. Because these cave faunas are composed of primarily aquatic species, they could be threatened by (1) groundwater contamination that results from saltwater intrusion due to excessive pumping of groundwater and from the introduction of agricultural and industrial chemicals as well as human and domesticated animal wastes into groundwater reservoirs. Groundwater contamination may also result from vandalism and other direct human-related disturbances.

Cave fauna kills have been documented on at least four occasions in caves associated with the Suwannee and Wakulla drainages. On one occasions, Streever (1992*b*) reported a complete faunal kill that included, not only cave crayfishes, but also yellow bullheads, American eels, and *Corbicula* clams. This event followed the introduction of cold flood waters into the cave from the Suwannee River which forced the spring to reverse. The kill may have resulted from sudden changes in water temperature, oxygen deprivation, or the introductions of toxic materials. Another catfish kill was noted at White Springs, but no other information is available about the conditions that may have sponsored this event (TM). Crustacean kills were also noted at Edwards Spring and Falmouth Spring-Siphon in May 1989. Unlike Streever's account, these springs had not reversed, and there was no injection of cold water. Over 50 cave crayfish (probably *Procambarus pallidus*) and large numbers of isopods and amphipods were found dead at Edwards Spring. Divers reported that they found blue pellets spread on the ground in a managed pine forest in the vicinity of several large sinks that formed the upstream portion of the Edwards Spring cave. They suggested that the pellets were possibly a herbicide used to control hardwoods in the plantation.

The Squirrel Chimney Cave Shrimp was federally listed as Threatened (Anonymous 1990), and the Florida Cave Amphipod, Hobbs' Cave Amphipod, and Orlando Cave Crayfish are being considered as candidates for listing by the U.S. Fish and Wildlife Service (Wood 1992). The Santa Fe Cave Crayfish is considered a Species of Special Concern by the State of Florida (Wood 1992). Most of the other Florida troglobitic fauna has been proposed by the Florida

Committee on Rare and Endangered Plants and Animals for listing by the state (Franz 1982).

Populations of the following troglobitic taxa have been found in caves that occur on federal, state, and private conservation lands where they receive some protection: *Dasyscias franzi* (Econfina Blue Spring Preserve [Northwest Water Management District]), *Caecidotea hobbsi* (Dudley Farm State Historical Site [Florida Park Service]), *Caecidotea* sp. 1 (Econfina Blue Spring Preserve), *Caecidotea* sp. 2 (Rock Springs County Park), *Remasellus parvus* (Peacock Springs State Preserve [Florida Park Service]), *Crangonyx grandimanus* (Peacock Springs State Preserve, Leon Sinks Recreation Area [U.S. Forest Service], Wakulla Springs State Park [Florida Park Service]), *C. hobbsi* (Dudley Farm State Historical Site, Peacock Springs State Preserve, Wakulla Springs State Park), *Procambarus acherontis* (Wekiwa Springs State Park [Florida Park Service]), *P. attiguus* (Silver Glen Springs Recreation Area [U. S. Forest Service]), *P. delicatus* (Alexander Springs Recreation Area [U.S. Forest Service]), *P. erythrops* (Sims Sink Preserve [The Nature Conservancy]), *P. lucifugus alachua* (Dudley Farm State Historical Site), *P. lucifugus* X *alachua* (Manatee Springs State Park [Florida Park Service]), *P. orcinus* (Wakulla Springs State Park, Leon Sinks Recreation Area), *P. pallidus* (Suwannee River State Park [Florida Park Service], Peacock Springs State Preserve), *Troglocambarus maclanei* (Manatee Springs State Park), *Cambarus cryptodytes* (Florida Caverns State Park [Florida Park Service]), *Pseudosinella pecki* (Florida Caverns State Park), *Islandiana* sp. (Florida Caverns State Park), and *Haideotriton wallacei* (Florida Caverns State Park). There is no such protection for six taxa (*Procambarus franzi*, *P. horsti*, *P. leitheuseri*, Marion population of *Procambarus lucifugus* X *alachua*, *P. morrisi*, and *Troglocambarus* sp.). Important populations of these invertebrates should be incorporated into future land acquisition projects in order to reduce their chances of extinction.

CONCLUSIONS

More survey work is needed in Florida and south Georgia to understand the complex relationships between the regional faunas. New troglobites undoubtedly await discovery when cavers and cave divers explore karst windows outside normally visited areas. Large areas of the state still remain uncharted. We recommend that divers wishing to assist in future biological discoveries look in the Choctawhatchee River basin, Econfina Creek karst area in Bay and Washington counties, scarp areas between Tallahassee and the Suwannee

River, Georgia portions of the (northern) Withlacoochee River and the Flint River, St. Johns River basin, and southern Florida.

We encourage the collections of specimens of both macro- and micro-invertebrates that represent new records; specimens should be preserved in alcohol (70% ethanol) at the time of collection. All specimens should be donated to appropriate collections where they can be properly studied and curated. If maintained alive, specimens need to be brought to a specialist immediately, for upon death these fragile organisms decay rapidly and are useless.

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APPENDIX 1. List of biologically significant caves and springs in Florida and South Georgia. Sites are listed by county. Pertinent data for each site include an identification code, accepted site name (and other names when appropriate), location (section, township, range, and name of the appropriate U. S. Geological Survey quadrangle map), regional faunas and assemblages, list of species (collection, authority, or reference), ownership, and relevant references with annotations (abbreviations represent troglobitic taxa). Abbreviations used in this section are as follows: Cl=*Cambarincola leoni*, Ua=*Uncinocythere ambophora*, Ul=*U. lucifuga*, Uw=*U. warreni*, Cah=*Caecidotea hobbsi*, Rp=*Remasellus parvus*, Ch=*Crangonyx hobbsi*, Cg=*C. grandimanus*, Pc=*Palaemonetes cummingi*, Pa=*Procambarus acherontis*, Pat=*P. attiguus*, Pd=*P. delicatus*, Pe=*P. erythrops*, Ph=*P. horsti*, Pf=*P. franzi*, Ple=*P. leitheuseri*, Pla=*P. lucifugus alachua*, Pll=*Procambarus lucifugus lucifugus*, PlXa=*P. lucifugus* intergrade, Pmi=*P. milleri*, Pm=*P. morrisi*, Po=*P. orcinus*, Pp=*P. pallidus*, Cc=*Cambarus cryptodytes*, Tm=*Troglocambarus maclanei*, Tsp=*Troglocambarus* sp., Psp=*Pseudosinella pecki*, Ip=*Islandiana* sp., Df=*Dasyscias franzi*, Hw=*Haideotriton wallacei*. Other abbreviations are listed in the Methods and Acknowledgments sections.

ALACHUA COUNTY

ALA-1. ALACHUA SINK (or Lime Sink, Alachua Green Sink) (Sec.10, T.8S, R.18E, Alachua Quad.). OCALA FAUNA (Upper Suwannee), *Procambarus pallidus* (USNM), unidentified cave amphipods (TM). Private, susceptible to groundwater pollution from parking lot run-off. REFERENCES: Franz and Lee 1982 (Pp).

ALA-2. AULSBROOK CAVE (Sec.35, T.9S, R.17E, Newberry Quad.). OCALA FAUNA (Upper Suwannee), *Caecidotea hobbsi* (RF). Private. REFERENCES: Franz 1982 (Cah).

ALA-3. BARBIES CAVE (Sec.14, T.10S, R.17E, Archer Quad.). OCALA FAUNA (Upper Suwannee), unidentified cave crayfishes (FSS files). Private.

ALA-4. BAT CAVE (Sec.18, T.9S, R.17E, Waters Lake Quad.). OCALA FAUNA (Upper Suwannee), *Caecidotea hobbsi* (USNM), *Procambarus lucifugus alachua* (USNM), and other cave associated species. Private. REFERENCES: Franz 1982 (Pla); Hobbs et al. 1977 (Pla); NcNab 1974 (bats); Relyea and Sutton 1973*b* (Pla, fish); Rice 1957 (bats).

ALA-5. BUZZARD'S ROOST (Sec.28, T.8S, R.18E, Alachua Quad.). OCALA FAUNA (Upper Suwannee), unidentified cave crayfishes. Private.

ALA-6. CHIMNEY SINK (unidentified site). OCALA FAUNA (Upper Suwannee), *Procambarus pallidus* (USNM), other cave-associated species. Private. REFERENCES: Franz 1982 (Pp); Hobbs et al. 1977 (Pp).

ALA-7. CRUMBLY SINK (Sec.22, T.9S, R.17E, Newberry Quad.). OCALA FAUNA (Upper Suwannee), *Crangonyx hobbsi* (JRH), *Procambarus lucifugus alachua* (USNM). Private.

ALA-8. CUEVA FRIA (Sec.24, T.10S, R.18E, Arrendondo Quad.). OCALA FAUNA (Upper Suwannee), *Procambarus lucifugus alachua* (USNM), *Procambarus pallidus* (USNM). Private. REFERENCES: Franz 1982 (Pla, Pp); Hobbs 1942*b* (Pla).

ALA-9. COW SINK (Sec.21, T.9S, R.17E, Newberry Quad.) OCALA FAUNA (Upper Suwannee), cave-associated species. REFERENCES: Marshall 1947 (fish).

ALA-10. DEVIL'S HOLE (or Glover Sink) (Sec.18, T.10S, R.18E, Archer Quad.). OCALA FAUNA (Upper Suwannee), *Crangonyx hobbsi* (Hobbs 1942*b*), *Procambarus pallidus* (USNM), other cave-associated species. Private. REFERENCES: Franz 1982 (Ch, Pp); Hobbs 1942*b* (Ch, Pp); Hobbs et al. 1977 (Pp).

ALA-11. DOUBLE-BARREL SINK (or Double Sink Cave) (Sec. 24, T.10S, R.17E, Archer Quad.). OCALA FAUNA (Upper Suwannee), unidentified cave crayfishes (BHT, pers. comm., 1975). Private.

ALA-12. DUDLEY CAVE (Sec.32, T.9S, R.18E, Newberry Quad.). OCALA FAUNA (Upper Suwannee), *Caecidotea hobbsi*-type locality (USNM), *Crangonyx hobbsi* (JRH), *Procambarus lucifugus alachua* (USNM), other cave-associated species. Public, Dudley Farm State Historical Site, Florida Dept. Natural Resources. REFERENCES: Franz 1982 (Cah, Ch, Pla); Hobbs 1942*b* (Cah, Ch, Pla); Krause 1990*a* (cave description, map); Maloney 1939 (Cah-type description); Peck 1970 (terrestrial arthropods); Warren 1961 (Cah, Ch, Pla).

ALA-13. DUDLEY TUNNEL (or Dudleys Cave II) (Sec.32, T.9S, R.18E, Newberry Quad.). OCALA FAUNA (Upper Suwannee), *Caecidotea hobbsi* (USNM). Public, Dudley's Farm State Historical Site, Florida Dept. Natural Resources. REFERENCES: Franz 1982 (Cah); Hobbs 1942 (Cah); Krause 1990*a* (cave description, map); Warren 1961 (Cah).

ALA-14. DUFF'S CAVE (Sec.14, T.10S, R.17E, Archer Quad.). OCALA FAUNA (Upper Suwannee), unidentified cave crayfishes (FSS files). Private.

ALA-15. FELLOE CAVE (Sec.2, T.10S, R.18E, Gainesville West Quad.). OCALA FAUNA (Upper Suwannee), unidentified cave crayfishes (FSS files). Private.

ALA-16. FERN CAVE (or Fern Sink) (Sec.34, T.8S, R.17E, Newberry Quad.). OCALA FAUNA (Upper Suwannee), unidentified cave crayfish (FSS files), other cave-associated species. Private.

ALA-17. GOAT SINK (Sec.20, T.9S, R.18E, Newberry Quad.). OCALA FAUNA (Upper Suwannee), *Crangonyx hobbsi*, *Procambarus lucifugus alachua* (USNM), *Procambarus pallidus*, *Troglocambarus maclanei* (USNM), other cave-associated species. Private. REFERENCES: Cooper 1965*b* (Pla, cave description); Hobbs 1942*b* (Pla); Hobbs et al. 1977 (Pla, Pp); Holt 1973*b* (Cl as commensal on Pla); Lee 1969*c* (bullfrogs); Warren 1961 (Pla).

ALA-18. GRANT'S CAVE (Sec.3, T.10S, R.18E, Newberry Quad.). OCALA FAUNA, cave-associated species. Private. REFERENCES: Peck 1970 (terrestrial arthropods); Rice 1957 (bats).

ALA-19. HAGUE CAVE (Sec.9, T.8S, R.18E, High Springs Quad.). OCALA FAUNA (Upper Suwannee), unidentified cave crayfishes (FSS files). Private.

ALA-20. HERTZOG CAVE (or Herzog's Cave, Wagon Wheel Cave) (Sec. line 17/18, T.10S, R.19E, Arrendondo Quad.). OCALA FAUNA (Upper Suwannee), *Crangonyx grandimanus* (JRH), *Procambarus pallidus* (USNM), *Troglocambarus maclanei* (USNM). Private.

ALA-21. HIGH SPRINGS CAVE (Sec.2, T.8S, R.17E, High Springs Quad.). OCALA FAUNA (Upper Suwannee), *Crangonyx hobbsi*, *Procambarus pallidus* (USNM). Private. REFERENCES: Franz 1982 (Ch, Pp); Hobbs 1942*b* (Ch, Pp); Hobbs et al. 1977 (Pp); Warren 1961 (Ch, Pp).

ALA-22. HOG SINK (Sec.24, T.10S, R.18E, Arrendondo Quad.). OCALA FAUNA (Upper Suwannee), *Uncinocythere lucifuga* (Walton and Hobbs 1959), *Procambarus lucifugus alachua*-type locality (USNM), *Procambarus pallidus* (USNM), other cave-associated species. Private. REFERENCES: Franz 1982 (Ch, Pla); Franz and Lee 1982 (Pla); Hobbs 1942*b* (Pla); Hobbs et al. 1977; (Pla) Marshall 1947 (fish); Rice 1957 (bats); Walton and Hobbs 1959 (Ul); Warren 1961 (Ch, Pla, Pp).

ALA-23. HORNSBY SINK (Sec.26, T.7S, R.17E, High Springs Quad.). OCALA FAUNA (Upper Suwannee), *Procambarus pallidus* (USNM). Private, children's camp. REFERENCES: Franz 1982 (Pp); Hobbs et al. 1977 (Pp).

ALA-24. HORNSBY SPRING (Sec.27, T.7S, R.17E, High Springs Quad.). OCALA FAUNA (Upper Suwannee), *Procambarus pallidus*

(ATL). Private, children's camp. REFERENCES: Auffenberg 1957*a* (fossils); Dolan and Allen 1961 (archeology), Lane 1986 (geology), Rosenau et al. 1977 (spring description); Webb 1974 (fossils).

ALA-25. HUGGINS CAVE (Sec.35, T.8S, R.17E, Newberry Quad.). OCALA FAUNA (Upper Suwannee), *Crangonyx grandimanus*, *Crangonyx hobbsi*-type locality (USNM). Private. REFERENCES: Franz 1982 (Cg, Ch); Shoemaker 1941 (Ch-type description); Warren 1961 (Cg, Ch).

ALA-26. JEROME SINK (Sec.22, T.9S, R.17E, Newberry Quad.). OCALA FAUNA (Upper Suwannee), unidentified cave crayfishes (FSS files), other cave-associated species. Private. REFERNCES: Marshall 1947 (fish).

ALA-27. JONES CAVE (or Witches Den) (Sec.17, T.9S, R.17E, Waters Lake Quad.). OCALA FAUNA (Upper Suwannee), cave-associated species. REFERENCES: McNab 1974 (bats).

ALA-28. JOOK'S CAVE (unidentified site). OCALA FAUNA (Upper Suwannee), cave-associated species. REFERENCES: Hubbell 1936 (crickets); Peck 1970 (terrestrial arthropods).

ALA-29. MARTIN'S CAVE (possibly Seven Chimneys) (Sec.18, T.9S, R.17E, Waters Lake Quad.). OCALA FAUNA (Upper Suwannee), *Procambarus lucifugus alachua*, other cave-associated species. Private. REFERENCES: Franz 1982 (Pla); Relyea and Sutton 1973*b* (Pla, catfish).

ALA-30. MCGEEHEE BLUE HOLE (Sec.15, T.9S, R.17E, Newberry Quad.). OCALA FAUNA (Upper Suwannee), *Procambarus pallidus* (ATL). Private.

ALA-31. MCGEEHEE CHIMNEY (Sec.16, T.9S, R.17E, Newberry Quad.). OCALA FAUNA (Upper Suwannee), unidentified cave crayfishes (FSS files). Private.

ALA-32. O'STEEN'S CAVE (Sec.26, T.8S, R.17E, High Springs Quad.). OCALA FAUNA (Upper Suwannee), cave-associated species. REFERENCES: Hubbell 1936 (crickets); Peck 1970 (terrestrial arthropods).

ALA-33. PALLIDUS SINK (Sec.15, T.8S, R.17E, High Springs Quad.). OCALA FAUNA (Upper Suwannee), *Procambarus pallidus* (USNM). Private. REFERENCES: Franz 1982 (Pp); Hobbs 1942*b* (Pp); Hobbs et al. 1977 (Pp); Warren 1961 (Pp).

ALA-34. POWERHOUSE SINK (Sec.22, T.8S, R.18E, Alachua Quad.). OCALA FAUNA (Upper Suwannee), unidentified crayfishes (FSS files). Private.

ALA-35. PROTHEROE SINK (Sec.24, T.10S, R.18, Arrendondo Quad.). OCALA FAUNA (Upper Suwannee), *Procambarus lucifugus*

alachua (Cooper 1965*b*), *Procambarus pallidus* (Cooper 1965*b*). Private. REFERENCES: Cooper 1965*b* (Pla, Pp, cave description); Franz 1982 (Pla. Pp); Hobbs et al. 1977 (Pla, Pp); Warren 1961 (Pla, Pp).

ALA-36. SCHOUTEN CAVE (Sec.5, T.10S, R.18E, Newberry Quad.). OCALA FAUNA (Upper Suwannee), unidentified cave crayfishes (FSS files). Private.

ALA-37. SEVEN CHIMNEYS SINK (Sec.17, T.9S, R.17E, Waters Lake Quad.). OCALA FAUNA (Upper Suwannee), *Procambarus lucifugus alachua*. REFERENCES: Franz 1982 (Pla); Hobbs et al. 1977 (Pla); McNab 1974 (bats).

ALA-38. SQUIRREL CHIMNEY (Sec.21, T.9S, R.18E, Newberry Quad.). OCALA FAUNA (Upper Suwannee), *Uncinocythere lucifuga* (Walton and Hobbs 1959), *Palaemonetes cummingi*-type locality (USNM), *Procambarus lucifugus alachua*, *Procambarus pallidus* (USNM), *Troglocambarus maclanei*-type locality (USNM), other cave-associated species. Private. REFERENCES: Anonymous 1990 (Pc, federal conservation status); Dickson and Franz 1980 (Pp, gill respiration); Dobkin 1971 (Pc, larval development); Franz 1982 (Ch, Pc, Pla, Pp, Tm); Franz and Lee 1982 (Pla, Pp, Tm, ecology); Hobbs 1942*a* (Tm-type description), 1942*b* (Pp, Tm); Hobbs et al. 1977 (Pla, Pp, Tm); Holt 1973*b* (Cl as commensal of TM); Mohr and Poulson 1966 (Pla, Tm, cave description, photo); Morris and Butt 1992 (Pc, cave description); Peck 1970 (terrestrial arthropods); Relyea and Sutton 1973*a* (Pp, egg-bearing); Walton and Hobbs 1959 (Ul); Warren 1961 (Pp, Tm).

ALA-39. STILL SINK (Sec.29, T.9S, R.18E, Newberry Quad.). OCALA FAUNA (Upper Suwanneee), *Crangonyx hobbsi* (JRH), *Procambarus pallidus* (USNM). Private. REFERENCES: Cooper 1965*b* (Pp, cave description); Franz 1982 (Pp); Hobbs, et al. 1977 (Pp).

ALA-40. TEN INCH CAVE (Sec.3, T.9S, R.17E, Newberry Quad.). OCALA FAUNA (Upper Suwannee), *Remasellus parvus*-type locality (USNM). Private. REFERENCES: Steeves 1964 (Rp, type description).

ALA-41. TUSK CAVE (Sec.34, T.9S, R.18E, Gainesville West Quad.). OCALA FAUNA (Upper Suwannee), *Procambarus lucifugus alachua* (USNM). Private. REFERENCES: Franz and Lee 1982 (Pla).

ALA-42. WARREN CAVE (Sec.13, T.9S, R.18E, Gainesville West Quad.). OCALA FAUNA (Upper Suwannee), *Procambarus pallidus*-type locality (USNM), other cave-associated species. Private, National Speleological Society, cave preserve. REFERENCES: Franz 1982 (Pp); Franz and Lee 1982 (Pp); Hobbs 1942*b* (Pp, type description);

Hobbs et al. 1977 (Pp); Krause 1992 (cave description, map); McNab 1974 (bats); Peck 1970 (terrestrial arthropods); Warren 1961 (Pp).

ALA-43. WELL, FORT CLARK CHURCH. (Sec.31-32, T.9S. R.19E, Gainesville West. Quad.). OCALA FAUNA (Upper Suwannee), *Procambarus pallidus* (USNM). Private. REFERENCES: Franz 1982 (Pp); Hobbs et al. 1977 (Pp).

ALA-44. WELL, MICANOPY (Unidentified site). OCALA FAUNA (Orange Lake), *Caecidotea hobbsi* (USNM). Private. REFERENCES: Steeves 1964 (Cah).

ALA-45. WELL, MICANOPY (Archie Carr Farm) (Sec.34, T.11S, R.20E, Flemington Quad.). OCALA FAUNA (Orange Lake), *Crangonyx grandimanus* (JRH), *Crangonyx hobbsi* (JRH). Private.

ALA-46. ZAMIA SINK (Sec.8, T.10S, R.18E, Newberry Quad.). OCALA (Upper Suwannee), cave-associated species. REFERENCES: Marshall 1947 (fish).

ALA-47. 32-FOOT CAVE (Sec.18, T.10S, R.19E, Gainesville West Quad.). OCALA FAUNA (Upper Suwannee), *Procambarus pallidus* (USNM). Private. REFERENCES: Franz and Lee 1982 (Pp).

CITRUS COUNTY

CIT-1. CAVE (6 mi N of Lecanto). OCALA FAUNA (Withlacoochee), cave-associated species. REFERENCES: McNab 1974 (bats).

CIT-2. BLOWING HOLE CAVE (Sec.21, T.20S, R.19E, Brooksville NW Quad.). OCALA FAUNA (Withlacoochee), cave-associated species. Public, Withlacoochee State Forest, Florida Dept. Agriculture, gated cave. REFERENCES: Hubbell 1936 (crickets); Peck 1970 (terrestrial arthropods).

CIT-3. DR. DAMES CAVE (or Dr. Doan's Cave) (Sec.30, T.20S, R.19E, Brooksville NW Quad.). OCALA FAUNA (Withlacoochee), cave-associated species. Public, Withlacoochee State Forest, Florida Dept. Agriculture. REFERENCES: Hubbell 1936 (crickets); Peck 1970 (terrestrial arthropods).

CIT-4. HALL'S BAT CAVE (or Rock Pile Cave, also known as Trail 10 Cave) (Sec.30, T.19S, R.18E, Brooksville NW Quad.). OCALA FAUNA (Withlacoochee), cave-associated species. REFERENCES: Lee field notes.

CIT-5. HOMOSASSA SPRINGS. (Sec.28, T.19S., R.17E., Homosassa Quad.). OCALA FAUNA (?), unidentified cave amphipods and isopods. Public, Homosassa Springs State Park, Florida Dept. Natural Resources. REFERENCES: Rosenau et al. 1977; Karst Environ-mental Services (cave map).

CIT-6. RESTINGHOUSE SIPHON (Sec.28, T.19S., R.17E, Homosassa Quad.). OCALA FAUNA, cave-associated species (snails). Private.

CIT-7. SWEET GUM CAVE (Sec.36, T.20S, R.19E, Nobleton Quad.). OCALA FAUNA (Withlacoochee), *Crangonyx hobbsi* (JRH), *Procambarus lucifugus lucifugus*-type locality (USNM), *Troglocambarus maclanei* (USNM), other cave-associated species. Private. REFERENCES: Faxon 1898 (Pll as Pa); Franz 1982 (Pll); Hobbs 1940*a* (Pll, type description); 1942*b* (Pll); Hobbs et al. 1977 (Pll); Hobbs III 1992 (photo of Pll); Hubbard 1901 (terrestrial arthropods); Mohr and Poulson 1966 (Pll); Warren 1961 (Pll).

COLUMBIA COUNTY

COL-1. BIG GRUNGY SWALLET (Sec.22, T.7S, R.17E, High Springs Quad.). OCALA FAUNA (Upper Suwannee), *Procambarus pallidus* (USNM), unidentified cave amphipods (TM). Public, O'Leno State Park, Florida Dept. Natural Resources. REFERENCES: TM (map).

COL-2. BIG ROOM CAVE SINK (Sec.18, T.7S, R.17E, Fort White Quad.). OCALA FAUNA (Upper Suwannee), *Procambarus pallidus* (TM), unidentified cave amphipods (TM). Private.

COL-3. BUSSEY SINK (Sec.18, T.7S, R.17E, Fort White Quad.). OCALA FAUNA (upper Suwannee), *Crangonyx hobbsi* (JRH), *Procambarus pallidus* (USNM), other cave-associated species. Private.

COL-4. COLUMBIA SPRINGS (or Olustee Creek Spring) (Sec.29, T.6S, R.18E, Mikesville Quad.). OCALA FAUNA (Upper Suwannee), *Procambarus pallidus* (TM). Private. REFERENCES: TM (map).

COL-5. FOSSIL CAVE SINK (or Jebs Hole) (sensitive, T.7S, R.17E, High Springs SW Quad.). Private. OCALA FAUNA (Upper Suwannee), *Procambarus pallidus* (TM), *Troglocambarus maclanei* (TM), unidentified cave amphipods (TM). REFERENCES: TM (map).

COL-6. JUG SPRING (or Blue Hole Spring) (Sec.7, T.6S, R.16E, Hildreth Quad.). OCALA FAUNA (Upper Suwannee), unidentified cave amphipods and isopods (TM), other cave-associated species. Public, Ichetucknee River State Park, Florida Dept. Natural Resources. REFERENCES: Rosenau, et. al. 1977 (spring description); Auffenberg 1957*b* (fossils, cave map).

COL-7. RIVERBED CAVE (Sec.19, T.7S, R.17E, High Springs SW Quad.). OCALA FAUNA (Upper Suwannee), *Crangonyx hobbsi* (Hobbs 1942b), *Procambarus pallidus* (USNM), other cave-associated species. Private, railroad right-of-way. REFERENCES: Franz 1982 (Pp); Hobbs 1940*a* (Pp), 1942*b* (Ch, Pp, cave description); Hobbs et al. 1977 (Pp); Warren 1961 (Ch, Pp).

COL-8. ROBINS NEST SPRING/SIPHON. (Sec.35, T.6S, R.16E, Fort White Quad.). OCALA FAUNA (Upper Suwannee), unidentified cave amphipods and crayfishes (TM). Private.

COL-9. ROSE CREEK SWALLET I (or Duckweed I) (Sec.10, T.5S, R.16E, Columbia Quad.). OCALA FAUNA (Upper Suwannee), *Procambarus pallidus* (USNM), unidentified cave amphipods and isopods (TM), other cave-associated species. Private. REFERENCES: TM (map).

COL-10. ROSE CREEK OVERFLOW SWALLET (or Duckweed II) (Sec. 15, T.5S, R.16E, Columbia Quad.). OCALA FAUNA (Upper Suwannee), *Procambarus pallidus* (TM), unidentified cave ampipods and isopods (TM), other cave-associated species. Private. REFERENCES: TM (map).

COL-11. RUSSELL'S RUB (Sec.1, T.6S, R.15E, Hildreth Quad.). OCALA FAUNA (Upper Suwannee), *Procambarus pallidus* (TM). Private.

COL-12. SHILOH CAVE (or Railroad Cave) (Sec.13, T.7S, R.16E, Fort White Quad.). OCALA FAUNA (Upper Suwannee), *Procambarus pallidus* (USNM). Private, railroad right-of-way.

COL-13. SIPHON CREEK CAVE (Sec.28, T.7S, R.16E, High Springs SW Quad.). OCALA FAUNA (Upper Suwannee), cave-associated species. Public, state waters.

COL-14. TROOP SINK (sensitive, T.5S, R.14E, O'Brien SE Quad.). OCALA FAUNA (Upper Suwannee), unidentified crayfishes (*Procambarus lucifugus* complex ?) (TM). Private. REFERENCES: TM (map).

COL-15. WHITE SPRINGS (Sec.7, T.2S., R.16E, White Springs West Quad.). OCALA FAUNA (Upper Suwannee), cave-associated species. REMARKS: Catfish kill in cave (TM).

DADE COUNTY

DAD-1. WELL, LITTLE BIRD NURSERY AND GARDEN STORE (Sec.15, T.54S, R.40E, South Miami Quad.). MIAMI FAUNA, *Crangonyx grandimanus* (JRH), *Crangonyx hobbsi* (JRH), *Procam-barus milleri*-type locality (USNM), other cave-associated species. Private, commercial site. REFERENCES: Franz 1982 (Pmi); Franz and Lee 1982 (Pmi); Hobbs 1971 (Pmi-type description); Hobbs et al. 1977 (Pmi); Holsinger 1972 (Ch, Cg).

DAD-2. WELL 4.5 KM NORTHEAST OF HOMESTEAD (Sec.29, T.56S, R.39E, Goulds Quad.). MIAMI FAUNA, *Procambarus milleri* (USNM). Private. REMARKS: Five specimens were taken from a nine meter deep well in the Biscayne aquifer on 1 June 1992 and 22 August

1992 by W. F. Loftus and P. Radice (W. F. Loftus and HHH, pers. comm.).

GILCHRIST COUNTY

GIL-1. DEVIL'S EYE AND EAR SPRINGS (Sec.34, T.7S, R.16E, Hildreth Quad.). Ginnie Springs Cave System. OCALA FAUNA (Upper Suwannee), *Crangonyx grandimanus* (JRH), *Crangonyx hobbsi* (JRH), *Procambarus pallidus* (USNM), *Troglocambarus maclanei* (USNM). Public, state waters, proximity of commercial recreation area. REFERENCES: Franz and Lee 1982 (Pp); Rosenau et al. 1977 (spring description).

GIL-2. GINNIE SPRINGS (Sec.34, T.7S, R.16E, High Springs Quad.). Ginnie Springs Cave System. OCALA FAUNA (Upper Suwannee), *Procambarus pallidus* (Pp). Private, commercial recreation area. REFERENCES: Franz and Lee 1982 (Pp); Rosenau et al. 1977 (spring description).

GIL-3. HART SPRINGS (Sec. 30, T.9S, R.14E, Wannee Quad.). OCALA FAUNA (Lower Suwannee), unidentified cave crayfishes and amphipods (TM). Public, Hart Springs County Park, Gilchrist County.

GIL-4. KELLEY'S SINKS (Sec.34, T.8S, R.14E, Wannee Quad.). OCALA FAUNA (Lower Suwannee), *Procambarus lucifugus X alachua* (RF). Private. REFERENCES: Franz and Lee 1982 (PlXa); FSS files.

GIL-5. LITTLE DEVIL'S SPRING (Sec.34, T.7S, R.16E, High Springs SW Quad.). OCALA FAUNA (Upper Suwannee), unidentified cave amphipods (TM). REFERENCES: WS (map).

GIL-6. OLD WALKER FARM SINKS (Sec.3, T.9S, R.14E, Wannee Quad.). OCALA FAUNA (Lower Suwannee), *Procambarus lucifugus X alachua* (USNM). Private. REFERENCES: Franz 1982 (PlXa); Franz and Lee 1982 (PlXa).

GIL-7. OTTER SPRINGS (Sec.6, T.10S, R.14E, Wannee Quad.). OCALA FAUNA (Lower Suwannee), unidentified cave crayfishes and amphipods (TM), other cave-associated species (TM). Private, commercial recreation area. REFERENCES: Rosenau et. al. 1977 (spring description).

GIL-8. ROBERT'S CAVE (or Bells Bat Cave, Bat Hole) (Sec.11, T.9S, R.14E, Wannee Quad.). OCALA FAUNA (Lower Suwannee), *Procambarus lucifugus X alachua* (Warren 1961), other cave-associated species. Private. REFERENCES: Franz 1982 (PlXa); Hobbs et al. 1977 (PlXa); Holt 1973*b* (Cl as commensal on Pla); Rice 1957 (bats); Warren 1961 (PlXa).

GIL-9. ROCK BLUFF SPRING (Sec.9, T.8S, R.14E., Hatchbend Quad.). OCALA FAUNA (Upper Suwannee), *Crangonyx* sp.? (JRH), *Procambarus pallidus* (USNM). Private. REFERENCES: Rosenau et al. 1977 (spring description).

HAMILTON COUNTY

HAM-1. ADAMS SPRING/SIPHON (Sec.8, T.1S, R.12E, Ellaville Quad.). OCALA FAUNA (Upper Suwannee), *Procambarus pallidus* (TM). Private.

HAM-2. CORBET SPRING CAVE (Sec. 10, T.1N., R.11E., Octahatchee Quad.). OCALA FAUNA (Upper Suwannee), *Procambarus pallidus* (USNM). Private.

HAM-3. FIRECRACKER CAVE (Sec. 5, T.1N, R.11E., Octahatchee Quad.). OCALA FAUNA (Upper Suwannee), *Procambarus pallidus* (USNM), unidentified cave amphipods and isopods, other associated-cave species. Private. REFERENCES: Pruitt 1991*c*, 1992 (Pp, cave description, map, biota).

HAM-4. HYDRANT SPRING (sensitive, T.1S, R.12E, Ellaville Quad.). OCALA FAUNA (Upper Suwannee), unidentified cave crayfishes (TM). Public, state waters. REFERENCES: TM (map).

HAM-5. NATURAL BRIDGE SPRING (sensitive, T.1S, R.12E, Ellaville Quad.). OCALA FAUNA (Upper Suwannee), unidentified cave crayfishes. Public, Suwannee River State Park, Florida Dept. Natural Resources. REFERENCES: TM (map).

HAM-6. OVERFLOW SPRING CAVE (Sec.13, T.1S, R.11E, Ellaville Quad.). OCALA FAUNA (Upper Suwannee), *Procambarus pallidus* (USNM), unidentified cave amphipods (TM). Public, Suwannee River State Park, Florida Dept. Natural Resources.

HAM-7. POTT SPRING (sensitive, T.1N, R.11E, Ellaville Quad.). OCALA FAUNA (Upper Suwannee), *Procambarus pallidus* (TM), unidentified cave amphipods (TM). Private.

HAM-8. RAVINE INTERMITTENT SPRING (sensitive, T.1S, R.12E, Ellaville Quad.). unidentified cave crayfishes (TM). Private.

HAM-9. ROSSITER SPRING (sensitive, T.1N, R.11E, Octahatchee Quad.). OCALA FAUNA (Upper Suwannee), *Procambarus pallidus* (TM), unidentified cave amphipods (TM). Private.

HAM-10. SHALLOW SPRING (Sec.10, T.1N, R.11E, Ellaville Quad.). OCALA FAUNA (Upper Suwannee), *Procambarus pallidus* (USNM), unidentified cave amphipods (TM), cave-associated species (snails). Private.

HAM-11. UNDERHUNG SINK (Sec.23, T.1N, R.11E, Ellaville Quad.). OCALA FAUNA (Upper Suwannee), *Procambarus pallidus* (USNM). Private.

HERNANDO COUNTY

HER-1. CAVE (unidentified site 23.3 km [14 mi] N of Weekiwachee Springs). OCALA FAUNA (Withlacoochee), *Procambarus lucifugus lucifugus* (USNM). REMARKS: Two specimens (Form I male and female) collected by Albert Greenburg in 1937 (data with USNM specimens). Franz 1982 (Pll); Hobbs 1940*a* (Pll), 1942*b* (Pll); Hobbs et al. 1977 (Pll); Warren 1961 (Pll).

HER-2. DIE POLDER 2 SINK (Sec.5, T.23S, R.18E, Weekiwachee Springs Quad.). OCALA FAUNA (Gulf Coastal Lowlands), *Procambarus leitheuseri* (USNM). Private, boy scout camp. REFERENCES: Franz and Hobbs 1983 (Ple).

HER-3. DIE POLDER 3 SINK (Sec.5, T.23S, R.18E, Weekiwachee Springs Quad.). OCALA FAUNA (Gulf Coastal Lowlands), *Procambarus leitheuseri* (USNM), *Troglocambarus maclanei* (TM), other cave-associated species. Private, boy scout camp. REFERENCES: Franz and Hobbs 1983 (Ple).

HER-4. EAGLE'S NEST SINK (or Lost Sink) (Sec.21, T.22S, R.17E, Weekiwachee Springs Quad.). OCALA FAUNA (Gulf Coastal Lowlands), *Crangonyx grandimanus* (JRH), *Crangonyx hobbsi* (JRH), *Procambarus leitheuseri*-type locality (USNM), *Troglocambarus maclanei* (USNM), other cave-associated species. Private. REFERENCES: Franz and Hobbs 1983 (Ple-type description).

HER-5. LITTLE SALT SPRINGS (Sec.29, T.22S, R.17E, Weekiwachee Springs Quad.). OCALA FAUNA (Gulf Coastal Lowlands), *Procambarus leitheuseri* (ATL). Private. REFERENCES: Franz and Hobbs 1983 (Ple); Rosenau et al. 1977 (spring description).

HER-6. LITTLE SPRINGS (or Twin D's) (Sec.2, T.22S, R.17E, Weekiwachee Springs Quad.). OCALA FAUNA (Gulf Coastal Lowlands), *Procambarus leitheuseri* (ATL). Private, commercial attraction (Weekiwachee Springs). REFERENCES: Franz and Hobbs 1983 (Ple); Rosenau et al. 1977 (spring description), Wetterhall 1965 (hydrology).

HOLMES COUNTY

HOL-1. VORTEX BLUE SPRING (Sec.9, T.4N, R.17W, Prosperity Quad.). Unstudied cave crayfish (USNM), other cave-associated species. Private, commercial recreation site. REMARKS: This spring occurs in the Choctawhatchee drainage, west of the Marianna Lowlands of Jackson

County. At least three other large springs occur in this county (Rosenau et al. 1977). Recent collections of cave crustaceans in the Vortex system suggests that this spring area is in need of more explora-tions. REFERENCES: Helfman 1986 (fish); Rosenau et al. 1977 (spring description).

JACKSON COUNTY

JAC-1. BAT CAVE (unidentified site). APALACHICOLA FAUNA (Marianna Lowlands), cave-associated species. REMARKS: Hubbell (1936) indicated the cave was located on the bank of the Chipola River near Marianna. REFERENCES: Hubbell 1936 (crickets); Peck 1970 (terrestrial arthropods).

JAC-2. BLUE HOLE SPRING (Sec.21, T.5N, R.10W, Marianna Quad.). APALACHICOLA FAUNA (Marianna Lowlands), *Cambarus* cf. *cryptodytes* (USNM). Public, Florida Caverns State Park, Florida Dept. Natural Resources. REMARKS: Unusual crayfish specimen; more material is needed from this site in order to determine this population's specific identity (HHH).

JAC-3 BLUE SINK (Sec.2, T.3N, R.11N, Kynesville Quad.). APALACHICOLA FAUNA (Marianna Lowlands), *Haideotriton wallacei* (TM). Private.

JAC-4. CAVE-IN-WOODS (Sec.26, T.5N, R.11W, Cottondale East Quad.). APALACHICOLA FAUNA (Marianna Lowlands), *Cambarus cryptodytes* (RF), *Haideotriton wallacei* (RF). Private. REFERENCES: Franz and Lee 1982 (Cc).

JAC-5. CHINA CAVE (Sec.27, T.5N, R.10W, Marianna Quad.). APALACHICOLA FAUNA (Marianna Lowlands), *Haideotriton wallacei*, other cave-associated species. Public, Florida Caverns State Park, Florida Dept. Natural Resources. REFERENCES: Hobbs III 1992 (Hw, photo).

JAC-6. COFFIN SPRING (Sec.35, T.4N, R.11W, Kynesville Quad.). APALACHICOLA FAUNA (Marianna Lowlands), unidentified crayfishes (TM). REFERENCES: map (TM, WS).

JAC-7. ELLIS CAVE (or Honey Comb Hill Cave) (Sec.28, T.5N, R.10W, Marianna Quad.). APALACHICOLA FAUNA (Marianna Lowlands), *Cambarus cryptodytes* (USNM), *Haideotriton wallacei* (RF), other cave-associated species. Private. REFERENCES: Brockman and Bortone 1977 (fish); Franz 1982 (Cc); Hobbs et al. 1977 (Cc).

JAC-8. FLORIDA CAVERNS (commercial cave?) (Sec.27, T.5N, R.11E, Marianna Quad.). APALACHICOLA FAUNA (Marianna Lowlands), cave-associated species. Public, Florida Caverns State Park, Florida Dept. Natural Resources. REFERENCES: Lane 1986 (cave description); Peck 1970 (terrestrial arthropods); Vandel 1965*a* (biota).

JAC-9. GERARD'S CAVE (or Sam Smith Cave) (Sec.23, T.5N, R.11E, Cottondale East Quad.). APALACHICOLA FAUNA (Marianna Lowlands), *Caecidotea hobbsi* (USNM), *Cambarus cryptodytes* (USNM), *Haideotriton wallacei* (UF, USNM, NCSM, MCZ), other cave-associated species. Private. REFERENCES: Caine 1978 (Cc, ecology); Franz 1982 (Cc); Franz et al. 1971 (snails); Hobbs et al. 1977 (Cc); Lee 1969*a*, 1969*b*, 1969*c*, 1969*d* (cave-associated species); Pylka and Warren 1958 (Hw); Warren 1961 (Cah, Cc, Hw).

JAC-10. GEROME'S CAVE (or Bumpnose Cave) (Sec.18, T.5N, R.10W, Cottondale East Quad.). APALACHICOLA FAUNA (Mari-anna Lowlands). *Cambarus cryptodytes* (DSL), other cave-associated species.

JAC-11. HOLE-IN-WALL SPRING (Sec.5, T.4N, R.9W, Marianna Quad.). APALACHICOLA FAUNA (Marianna Lowlands), *Cambarus cryptodytes* (USNM), *Haideotriton wallacei* (UF), unidentified amphipods (TM). Private. REFERENCES: Exley 1978 (cave description, map).

JAC-12. JACKSON BLUE SPRING (Sec.33, T.5N, R.9W, Marianna Quad.). APALACHICOLA FAUNA (Marianna Lowlands), *Cambarus cryptodytes* (USNM), *Haideotriton wallacei* (JB). Public, state waters.

JAC-13. JUDGES CAVE (Sec.35, T.5N, R.10W, Marianna Quad.). APALACHICOLA FAUNA (Marianna Lowlands), *Cambarus cryptodytes* (Warren 1961), *Haideotriton wallacei* (Warren 1961). Public, Judges Cave Bat Preserve, Florida Game and Fresh Water Fish Commission. REFERENCES: Franz 1982 (Cc); Hobbs et al. 1977 (Cc); Warren 1961 (Cc, Hw).

JAC-14. LIMESTONE CAVE AT BLUE SPRING (unidentified site). APALACHICOLA FAUNA (Marianna Lowlands), cave-associated species. REMARKS: Hubbell (1936) listed the site as "...small limestone caves at Blue Spring."REFERENCES: Hubbell 1936 (crickets); Peck 1970 (terrestrial arthropods).

JAC-15. KRAMER'S CAVE (unidentified cave in Florida Caverns State Park). APALACHICOLA FAUNA (Marianna Lowlands), cave-associated species. Public, Florida Caverns State Park, Florida Dept. Natural Resources. REFERENCES: Franz et al. 1971 (snails).

JAC-16. MILLER'S CAVE (Sec.28, T.5N, R.10W, Marianna Quad.). APALACHICOLA FAUNA (Marianna Lowlands), *Cambarus cryptodytes* (RF), *Haideotriton wallacei* (RF), *Pseudosinella pecki* (Christiansen and Bellinger 1980), other cave-associated species. Public, Florida Caverns State Park, Florida Dept. Natural Resources. REFERENCES: Christiansen and Bellinger 1980 (Psp); Peck 1970 (terrestrial arthropods); Klimaszewski and Peck 1986 (beetles).

JAC-17. MILTON'S CAVE (Sec.13, T.5N, R.11W, Cottondale East Quad.). APALACHICOLA FAUNA (Marianna Lowlands), cave-associated fauna.

JAC-18. MILTON'S WELL CAVE (Sec.13, T.5N, R11W, Cottondale East Quad.). APALACHICOLA FAUNA (Marianna Lowlands), *Cambarus cryptodytes* (DSL), *Haideotriton wallacei* (DSL), other cave-associated species. Private. REFERENCES: Franz 1982 (Cc); Franz et al. 1971 (snails); Hobbs et al. 1977 (Cc).

JAC-19. MUD CAVE (Sec.3, T.4N, R.10E, Marianna Quad.). APALACHICOLA FAUNA (Marianna Lowlands), cave-associated species. Private. REFERENCES: Rice 1957 (bats).

JAC-20. OLD INDIAN CAVE (Sec.21, T.5N, R.10W, Marianna Quad.). APALACHICOLA FAUNA (Marianna Lowlands), cave-associated species. Public, Florida Caverns State Park, Florida Dept. Natural Resources. REFERENCES: Lee and Tuttle 1970 (bat protection); McNab 1974 (bats); Peck 1970 (terrestrial arthropods); Rice 1955*a*, 1955*b* (bats).

JAC-21. POOL CAVE (or Pond Cave, Salamander Cave) (Sec.27, T.5N, R.10W, Marianna Quad.). APALACHICOLA FAUNA (Marianna Lowlands), *Cambarus cryptodytes* (RF), *Haideotriton zwallacei* (UF), other cave-associated species. Public, Florida Caverns State Park, Florida Dept. Natural Resources. REFERENCES: Franz 1982 (Cc); Hobbs et al. 1977 (Cc).

JAC-22. POTTERY CAVE (Sec.27/28, T.5N, R.10W, Marianna Quad.). APALACHICOLA FAUNA (Marianna Lowlands), *Cambarus cryptodytes* (Warren 1961), other cave-associated species. Public, Florida Caverns State Park, Florida Dept. Natural Resources. REFERENCES: Franz 1982 (Cc); Franz et al. 1971 (snails); Hobbs et al. 1977 (Cc).

JAC-23. RAY'S CAVE (Sec.22, T.5N, R.11W, Cottondale East Quad.). APALACHICOLA FAUNA (Marianna Lowlands), *Cambarus cryptodytes*. Private. REFERENCES: FNAI record.

JAC-24. RIVER CAVE (unidentified cave in Florida Caverns State Park). APALACHICOLA FAUNA (Marianna Lowlands), cave-associated species. Public, Florida Caverns State Park, Florida Dept. Natural Resources. REFERENCES: Peck 1970 (terrestrial arthropods).

JAC-25. ROCKWELL CAVE (unidentified site). APALACHICOLA FAUNA (Marianna Lowlands), *Cambarus cryptodytes* (Franz 1982). REFERENCES: Franz 1982 (Cc); Hobbs et al. 1977 (Cc).

JAC-26. SODA STRAW CAVE (or Walt's Misery) (Sec.2, T.4N, R.10W, Marianna Quad.) APALACHICOLA FAUNA (Marianna Low-

lands), *Cambarus cryptodytes* (Warren 1961). Public, Florida Caverns State Park, Florida Dept. Natural Resources. REFERENCES: Franz 1982 (Cc); Hobbs et al. 1977 (Cc); Warren 1961.

JAC-27. "SPRING CAVE" (unidentified cave in Florida Caverns State Park). APALACHICOLA FAUNA (Marianna Lowlands), cave-associated species. Public, Florida Caverns State Park, Florida Dept. Natural Resources. REFERENCES: Peck 1970 (terrestrial arthropods).

JAC-28. SWEETWATER SPRING (=Bozell Spring) (Sec.16, T.7N, R.10W, Marianna Quad.). APALACHICOLA FAUNA (Marianna Lowlands), unidentifed cave crayfishes (TM). Private.

JAC-29. TWIN CAVE (Sec.6, T.4N, R.9W, Marianna Quad.). APALACHICOLA FAUNA (Marianna Lowlands), *Cambarus cryptodytes* (RF), *Haideotriton wallacei* (RF), unidentified cave amphipods and isopods (TM). Private. REFERENCES: Exley 1978 (cave description, map); Franz and Lee 1982 (Cc).

JAC-30. "TWO ENTRANCE CAVE" (unidentified cave in Florida Caverns State Park, possibly Millers Cave). APALACHICOLA FAUNA (Marianna Lowlands), cave-associated species. Public, Florida Caverns State Park, Florida Dept. Natural Resources. REFERENCES: Peck 1970 (terrestrial arthropods).

JAC-31. VETTER'S CAVE (Sec.27, T.5N, R.10W, Marianna Quad.). APALACHICOLA FAUNA (Marianna Lowlands), *Cambarus cryptodytes* (RF), other cave-associated species. Public, Florida Caverns State Park, Florida Dept. Natural Resources. REFERENCES: Franz 1982 (Cc); Franz et al. 1971 (snails); Hobbs et al. 1977 (Cc).

JAC-32. WADDELL'S MILL POND CAVE (Sec.33, T.6N, R.11W, Sills Quad.). APALACHICOLA FAUNA (Marianna Lowlands), *Cambarus cryptodytes* (USNM), other cave-associated species. Private. REFERENCES: Hobbs et al. 1977 (Cc).

JAC-33. WASHED-OUT CAVE (Sec.23, T.5N, R.11W, Cottondale East Quad.). APALACHICOLA FAUNA (Marianna Lowlands), *Cambarus cryptodytes* (Warren 1961), *Haideotriton wallacei* (Warren 1961). Private. REFERENCES: Franz 1982 (Cc); Hobbs et al. 1977 (Cc); Warren 1961 (Cc).

JAC-34. WELL, 2 mi south of Graceville (Sec.15, T.6N, R.13W, Graceville Quad.). APALACHICOLA FAUNA (Marianna Lowlands), *Cambarus cryptodytes*-type locality (USNM). Private. REMARKS: well filled (R. Williams, personal communication, Graceville, Florida, 1983). REFERENCES: Hobbs 1941 (Cc-type description), 1942*b* (Cc); Warren 1961 (Cc).

JEFFERSON COUNTY

JEF-1. WACISSA BIG BLUE SPRING (Sec.12, T.2S., R.3N, Wacissa Quad.). WOODVILLE FAUNA, *Procambarus horsti*-type locality (USNM), unidentified cave amphipods and isopods (TM). Public, state waters. REFERENCES: Hobbs and Means 1972 (Ph-type description); Hobbs et al. 1977 (Ph); Franz 1982 (Ph); Franz and Lee 1982 (Ph); Rosenau et al. 1977 (spring description).

LAFAYETTE COUNTY

LAF-1. ALLENS MILL POND SPRING (Sec.5, T.4S, R.11E, Dowling Park Quad). OCALA FAUNA (Upper Suwannee), *Procam-barus pallidus* (USNM), unidentified cave amphipods and isopods (TM). Public, Suwannee River Water Management District, recreation area. REFERENCES: Rosenau et al. 1977 (spring description).

LAF-2. ALLIGATOR RESCUE SPRING (Sec.25, T.4S, R.11E, Mayo Quad.). OCALA FAUNA (Upper Suwannee). *Procambarus pallidus* (TM). Public, state waters. REFERENES: map (TM).

LAF-3. BOBCAT SINK (Sec.21, T.4S, R.11E, Mayo Quad.). Lafayette Blue Spring System. OCALA FAUNA (Upper Suwannee), *Procambarus pallidus* (TM), unidentified cave amphipods (TM). Private.

LAF-4. GREEN SINK (Sec.21, T.4S, R.11E, Mayo Quad.). Lafayette Blue Spring System. OCALA FAUNA (Upper Suwannee), unidentified cave crayfishes, other cave-associated species (TM). Public, Blue Springs County Park, Lafayette County.

LAF-5. KASSERMAN SINK (Sec.1, T.6S, R.13E, Branford Quad.). Ruth Spring Cave System. OCALA FAUNA (Upper Suwannee), *Procambarus pallidus* (ATL). Private.

LAF-6. LAFAYETTE BLUE SPRING (Sec.21, T.4S, R.11E, Dowling Park Quad.). Lafayette Blue Spring Cave System. OCALA FAUNA (Upper Suwannee), *Procambarus pallidus* (ATL). Public, Blue Springs County Park, Lafayette County recreation area. REFERENCES: Rosenau et al. 1977 (spring description).

LAF-7. MAIN SINK (Sec.1, T.6S, R.13E, Branford Quad.). Ruth Spring Cave System. OCALA FAUNA (Upper Suwannee), *Procambarus pallidus* (ATL). Private.

LAF-8. OWENS SPRING (Sec.21, T.5S, R.13E, Mayo SE Quad.). OCALA FAUNA (Upper Suwannee), *Procambarus pallidus* (TM). Private.

LAF-9. PERRY SPRING (Sec.35, T.4S, R.11E, Mayo Quad.). OCALA FAUNA (Upper Suwannee), *Procambarus pallidus* (ATL), unidentified cave amphipods and isopods (TM). Private. REFERENCES: Rosenau et al. 1977 (spring description).

LAF-10. RUTH SPRING (Sec.1, T.6S, R.13E, Branford Quad.). Ruth Spring Cave System. OCALA FAUNA (Upper Suwannee), *Procambarus pallidus* (USNM). Private. REFERENCES: Rosenau et al. 1977 (spring description).

LAF-11. TROY SPRING (Sec.34, T.5S, R.13E, O'Brien Quad.). OCALA FAUNA (Upper Suwannee), *Procambarus pallidus* (USNM). Private. REFERENCES: Franz and Lee 1982 (Pp); Rosenau et al. 1977 (spring description).

LAKE COUNTY

LAK-1. ALEXANDER SPRINGS (Sec.39, T.16S, R.27E, Alexander Spring Quad.). ST. JOHNS RIVER FAUNA (Lake George), *Procambarus delicatus*-type locality (USNM), unidentified cave isopods (TM). Public, Ocala National Forest, U.S. Forest Service, recreation area. REFERENCES: Franz and Lee 1982 (unidentified crayfish); Hobbs and Franz 1986 (Pd-type description); Relyea et al. 1976 (unidentified crayfish); Rosenau et al. 1977 (spring description).

LAK-2. EUSTIS (unidentified site). OCALA FAUNA (? area), *Procambarus lucifugus* subspecies? (USNM). REFERENCES: Hobbs 1940*a* (PlX?); Hobbs 1942*b* (PlX?).

LEON COUNTY

LEO-1. BIRD SINK SWALLET (Sec.17, T.1N, R.3E, Lloyd Quad.). WOODVILLE FAUNA, unidentified cave crayfishes (possibly *Procambarus horsti*) (TM). Private.

LEO-2. CAVE, 3 mi. north of Woodville (unidentified site, possibly Gopher Sink). WOODVILLE FAUNA, *Procambarus orcinus* (USNM).

LEO-3. CLAY SINK (unidentified site, possibly Gopher Sink). WOODVILLE FAUNA, *Procambarus orcinus* (USNM) (listed in Warren [1961] as *Procambarus pallidus*). REFERENCES: Warren 1961 (Po).

LEO-4. CULLEY'S CAVE (Sec.17, T.2S, R.1W, Lake Munson Quad.). WOODVILLE FAUNA, *Procambarus orcinus* (USNM). Leon Sinks Recreation Area, Apalachicola National Forest, U.S. Forest Service. REFERENCES: Hobbs and Means 1972 (Po), Hobbs III 1992 (photo of sink).

LEO-5. GOPHER SINK (Sec.16, T.2S, R.1W, Lake Munson Quad.). WOODVILLE FAUNA, *Procambarus orcinus*-type locality (USNM), unidentified cave amphipods, other cave-associated species. Private. REFERENCES: Franz 1982 (Po); Hobbs et al. 1977 (Po); Hobbs and Means 1972 (Po, type description); Holt 1973b (Cl as commensal of Po).

LEO-6. LITTLE DISMAL SINK (Sec.17, T.2S, R.1W, Lake Munsion Quad.). WOODVILLE FAUNA, *Crangonyx grandimanus* (JRH), *Procambarus orcinus* (USNM), unidentifed cave amphipods and isopods (TM). Public, Leon Sinks Recreation Area, Appalachicola National Forest, U.S. Forest Service.

LEO-7. MUNSON SLOUGH BLUE (sensitive, T.2S, R.1W, Lake Munson Quad.). WOODVILLE FAUNA, unidentified cave crayfishes (TM). Private. REFERENCES: TM (map).

LEO-8. NATURAL BRIDGE SPRING (Sec.29, T.2S, R.2E, Woodville Quad.). WOODVILLE FAUNA, unidentified cave amphipods and crayfishes (TM). Private. REFERENCES: Lane 1986 (description).

LEO-9. OSGOOD SINK (Sec.11, T.2S, R.1E, Woodville Quad.). WOODVILLE FAUNA, *Procambarus orcinus* (USNM). Private. REFERENCES: Franz 1982 (Ph); Hobbs et al. 1977 (Ph); Hobbs and Means 1972 (Ph).

LEO-10. SULLIVAN'S TUNNEL (or Hole-in-the-Ground) (Sec.13, T.2S, R.2W, Hilliardville Quad.). WOODVILLE FAUNA, *Crangonyx hobbsi* (JRH), *Procambarus orcinus* (USNM), unidentified cave isopods (TM). Public, Apalachicola National Forest, U.S. Forest Service. REFERENCES: Knab 1991 (cave length).

LEO-11. WELL, 4.5 mi east of Tallahassee (unidentified site.). WOODVILLE FAUNA, *Procambarus horsti* (USNM). Private. REFERENCES: Franz 1982 (Ph); Hobbs et al. 1977 (Ph); Hobbs and Means 1972 (Ph).

LEVY COUNTY

LEV-1. ARCHER CAVES (Sec.4, T.12S, R.18E, Bronson NE Quad.). OCALA FAUNA (Upper Suwannee), *Crangonyx grandimanus* (JRH), *Procambarus pallidus* (USNM), other cave-associated species. Private. REFERENCES: Franz and Lee 1982 (Pp).

LEV-2. BLUE GROTTO (or Williston Blue Sink) (Sec.2, T.13S, R.18E, Williston Quad.). OCALA FAUNA (Lower Suwannee), *Procambarus lucifugus* X *alachua* (USNM). Private, commercial recreation area.

LEV-3. DEVIL'S DEN (Sec.26, T.12S, R.18E, Williston Quad.). OCALA FAUNA (Upper Suwannee), *Procambarus pallidus* (USNM). Private. REFERENCES: Kurten 1966 (fossils); Martin 1974 (fossils); Pruitt 1991*b* (cave description, map); Rice 1957 (bats); Webb 1974 (fossils).

LEV-4. FOUR CAVE (Sec.28, T.12S, R.18E, Bronson NE Quad.). OCALA FAUNA (Upper Suwannee), cave-associated species. Private. REFERENCES: Pruitt 1990 (cave description, fish).

LEV-5. FRIEDMAN'S SINK (Sec.35, T.11S, R.13E., Manatee Springs Quad.). Manatee Springs Cave System. OCALA FAUNA (Lower Suwannee), *Crangonyx hobbsi* (JRH), *Procambarus lucifugus* X *alachua* (USNM). Public, Manatee Springs State Park, Florida Dept. Natural Resources. REFERENCES: Exley 1984 (description, map, photo).

LEV-6. GUNPOWDER CAVE (Sec.26, T.12S, R.14E, Williston Quad.). OCALA FAUNA (Upper Suwannee), *Troglocambarus maclanei* (USNM), unidentified cave crayfishes (*Procambarus lucifugus* complex?). Private.

LEV-7. HALF MOON CAVE (Sec.29, T.12S, R.18E, Williston Quad.). OCALA FAUNA, cave-associated species. Private. REFERENCES: Marshall 1947 (fish).

LEV-8. MANATEE SPRINGS (Sec.26, T.11S, R.13E, Manatee Springs Quad.). Manatee Springs Cave System. OCALA FAUNA (Lower Suwannee). *Crangonyx hobbsi* (JRH), *Procambarus lucifugus* X *alachua* (USNM), *Troglocambarus maclanei* (USNM). Public, Manatee Springs State Park, Florida Dept. Natural Resources. REFERENCES: Exley 1984 (exploration, map, photos); Franz 1982 (PlXa); Franz and Lee 1982 (PlXa); Knab 1991 (cave length); Rosenau et al. 1977 (spring description).

LEV-9. OCTOPUS CAVE (Sec.4, T.12S, R.18E, Bronson NE Quad.). OCALA FAUNA (Upper Suwannee), associated cave fauna. Private. REFERENCES: Pruitt 1991*a* (description, map, fauna).

LEV-10. PEANUT CAVE (Sec.24, T.13S, R.18E, Morristown Quad.). OCALA FAUNA (Upper Suwannee), *Procambarus lucifugus alachua* (USNM). Private.

LEV-11. WELL, CHIEFLAND (unidentified site). OCALA FAUNA (Lower Suwannee), *Crangonyx grandimanus* (JRH), *Crangonyx hobbsi* (JRH). Private. REFERENCES: Franz 1982 (Ch).

MADISON COUNTY

MAD-1. BASELINE CAVE (Sec.33, T.1S, R.11E, Falmouth Quad.). OCALA FAUNA (Upper Suwannee), *Procambarus pallidus* (USNM), unidentified cave amphipods and isopods (TM). Private. REFERENCES: map (TM, BP).

MAD-2. MADISON BLUE SPRING (Sec.17, T.1N, R.11E, Ellaville Quad.). OCALA FAUNA (Upper Suwannee), *Crangonyx grandimanus* (JRH), *Crangonyx hobbsi* (JRH), *Procambarus pallidus* (ATL), other cave-associated species. Private. REFERENCES: Knab 1991 (cave length); Martin and Harris 1993 (mineralogy); Rosenau et al. 1977 (spring description).

MAD-3. M2 BLUE SPRING (Sec.32, T.2N, R.11E, Octahatchee Quad.). OCALA FAUNA (Upper Suwannee), *Procambarus pallidus* (USNM), other cave-associated species. Public, Suwannee River Water Management District. REFERENCES: Pruitt 1991*d*, 1992 (cave description, map).

MAD-4. SUWANNACOOCHEE SPRING (Sec.24, T.1S, R.11E., Ellaville Quad.). OCALA FAUNA (Upper Suwannee), *Procambarus pallidus* (USNM). Public, Suwannee River State Park, Florida Dept. Natural Resources. REFERENCES: Franz 1982 (Pp); Hobbs et al. 1977 (Pp); Rosenau et al. 1977 (spring description).

MAD-5. THUNDERHOLE SINK (Sec.10, T.1S, R.11E, Ellaville Quad.). OCALA FAUNA (Upper Suwannee), *Remasellus parvus* (USNM), *Procambarus pallidus* (USNM), unidentified cave amphipods (TM), other cave-associated species. Private. REFERENCES: Franz and Lee 1982 (Pp).

MARION COUNTY

MAR-1. BELLEVIEW CAVE (unidentified site, possibly Ocala Caverns). OCALA FAUNA (Marion), cave-associated species. REFERENCES: Peck 1970 (terrestrial arthropods).

MAR-2. BRIAR CAVE (Sec.35, T.15S, R.21E, Ocala West Quad.). OCALA FAUNA (Marion), *Procambarus lucifugus* X *alachua* (USNM). Private. REFERENCES: Johnson 1990; A. Krause 1990*b*; M. Krause 1990 (cave description, geology).

MAR-3. CHERT CAVE (Sec.10, T.16S, R.22E, Belleview Quad.). OCALA FAUNA (Marion), *Crangonyx hobbsi* (JRH), *Procambarus lucifugus* X *alachua* (USNM), *Troglocambarus maclanei* (USNM). Private.

MAR-4. COON CAVE (Sec.30, T.14S, R.22E, Anthony Quad.). OCALA FAUNA (Marion), *Procambarus lucifugus* X *alachua* (USNM). Private.

MAR-5. EICHELBERGER CAVE (Sec.2, T.17S, R.22E, Belleview Quad.). OCALA FAUNA (Marion), *Procambarus lucifugus* X *alachua* (USNM), *Procambarus pallidus*? (USNM). Private. REMARKS: Franz and Lee (1982) questioned the validity the *Procambarus pallidus* record. Unfortunately this cave was destroyed by limestone mining activities. REFERENCES: Auffenberg 1958, 1963 (fossils); Brodkorb 1956 (fossils); Franz 1982 (PlXa, Pp); Franz and Lee 1982 (PlXa, Pp); Hobbs et al. 1977 (PlXa, Pp).

MAR-6. FROG CRAWL CAVE (Sec. 15, T.14S, R.20E, Fairfield Quad.). OCALA FAUNA (Marion), unidentified cave crayfishes (FSS files). Private.

MAR-7. HELL HOLE (Sec.6, T.14S, R.21E, Reddick Quad.). OCALA FAUNA (Orange Lake), *Crangonyx hobbsi* (JRH), *Procambarus franzi* (USNM). Private. REFERENCES: Franz and Lee 1982 (Pf); Krause 1991 (cave description, map).

MAR-8. HOLLOWED GROUND CAVE. (Sec.36, T.15S, R.20E, Cotton Plant Quad.). OCALA FAUNA (Marion), *Caecidotea hobbsi*? (J. Lewis, personal communication). Private.

MAR-9. INDIAN CAVE (or Last Resort Cave) (Sec.36, T.15S, R.20E, Cotton Plant Quad.). OCALA FAUNA (Marion), *Crangonyx grandimanus*-type locality (NMC), *Crangonyx hobbsi* (USNM), *Procambarus lucifugus* X *alachua* (USNM), *Troglocambarus maclanei* (USNM). Private. REFERENCES: Bousfield 1963 (Cg, type description); Cooper 1965*a* (PlXa); Franz 1982 (Cg, PlXa, Tm); Hobbs 1942*b* (PlXa); Hobbs et al. 1977 (PlXa); Warren 1961 (PlXa).

MAR-10. JENNING'S CAVE (or Confederate Cave) (Sec.26, T.15S, R.19E, Romeo Quad.). OCALA FAUNA (Marion), cave-associated species. Private. REFERENCES: Peck 1970 (terrestrial arthropods).

MAR-11. MEFFORD CAVE (Sec.15, T.13S, R.21E, Reddick Quad.). OCALA FAUNA (Marion), cave-associated species. Private. REFERENCES: Auffenberg 1957*a*, 1958, 1963 (fossils); Gertsch 1984 (spiders); McNab 1974 (bats); Peck 1970 (terrestrial arthropods).

MAR-12. NICKELBERGER CAVE (Sec.2, T.17S, R.22E, Belleview Quad.). OCALA FAUNA (Marion), unidentified cave crayfishes, other cave-associated species (PS, BP, FSS files). Private.

MAR-13. OCALA CAVERNS (Sec.23, T.16S, R.22E, Belleview Quad.). OCALA FAUNA (Marion), *Procambarus lucifugus* X *alachua* (USNM). Private, previously commercialized. REFERENCES: Franz and Lee 1982 (PlXa).

MAR-14. ORANGE LAKE CAVE (Sec.34, T.12S, R.21E, McIntosh Quad.). OCALA FAUNA (Orange Lake), *Uncinocythere lucifuga* (AN), *Crangonyx hobbsi* (JRH), *Procambarus franzi*-type locality (USNM), *Troglocambarus maclanei* (USNM). Private. REFERENCES: Dickson and Franz 1980 (Pf, gill respiration); Davis and Rand 1982 (lime-encrusting algae); Franz 1982 (Ch, Pf, Tm); Franz and Lee 1982 (Tm); Hobbs and Lee 1976 (Pf, type description).

MAR-15. ORANGE LAKE QUARRY SOLUTION PITS (or Quarry Crevice Caves) (Sec.34, T.12S, R.21E, McIntosh Quad.). OCALA FAUNA (Orange Lake), *Procambarus franzi* (DSL). Private.

MAR-16. REDDING CATACOMBS (Sec.20, T.16S, R.22E, Shady Quad.). OCALA FAUNA (Marion), *Procambarus lucifugus* X *alachua* (RF). Private. REFERENCES: Franz and Lee 1982 (PlXa).

MAR-17. RAINBOW ACRES CAVE (unidentified site, possibly Jennings Cave). OCALA FAUNA (Marion), *Caecidotea hobbsi* (USNM).

MAR-18. ROOSEVELT CAVE (or Tillman's Cave) (Sec.32, T.15S, R.22E, Ocala East Quad.). OCALA FAUNA (Marion), *Caecidotea hobbsi* (USNM), *Crangonyx hobbsi* (Steeves 1964), *Procambarus lucifugus* X *alachua* (USNM). Private. REFERENCES: Franz 1982 (Ch, CaH, PlXa); Hobbs et al. 1977 (PlXa); Steeves 1964 (Cah); Warren 1961 (Cah, PlXa).

MAR-19. SILVER GLEN SPRINGS (Sec.25, T.14S, R.26E, Juniper Springs Quad.). ST. JOHNS RIVER FAUNA (Lake George), *Procambarus attiguus*-type locality (USNM), unidentified cave amphipods (TM), other cave-associated species. Public, Silver Glen Springs Recreation Area, U.S. Forest Service. REFERENCES: Hobbs and Franz 1992 (Pat); Rosenau et al. 1977 (spring description).

MAR-20. SILVER SPRINGS (Sec.6, T.15S, R.23E, Ocala East Quad.). ST. JOHNS RIVER FAUNA (Oklawaha), *Procambarus lucifugus* X *alachua* (USNM), unidentified cave amphipods and isopods (TM), other cave-associated species. Private, commercial recreation area. REFERENCES: Rosenau et al. 1977 (spring description).

MAR-21. STEEPLE CAVE (Sec.8, T.16S, R.22E, Shady Quad.). OCALA FAUNA (Marion), *Procambarus lucifugus* X *alachua* (Franz 1982). Private. REFERENCES: Franz 1982 (PlXa); Hobbs et al. 1977 (PlXa).

MAR-22. SUNDAY SINK (Sec.8, T.16S, R.22E, Shady Quad.). OCALA FAUNA (Marion), *Crangonyx hobbsi* (JRH), *Procambarus lucifugus* X *alachua* (USNM), *Troglocambarus maclanei* (USNM), other cave-associated species. Private. REFERENCES: Franz 1982 (PlXa, Tm); Franz and Lee 1982 (Tm); Hobbs et al. 1977 (PlXa, Tm).

MAR-23. TRADE WINDS FARM CAVE (unidentified site). OCALA FAUNA (Orange Lake), *Procambarus franzi* (USNM), *Troglocambarus maclanei* (USNM). Private.

MAR-24. VILLA HEIGHTS CAVE (unidentified site). OCALA FAUNA (Marion), cave-associated species. REMARKS: Hubbell (1936) noted that the cave was located 51.6 km (31 miles) south of Gainesville on State Highway 2. REFERENCES: Hubbell 1936 (crickets); Peck 1970 (terrestrial arthropods).

MAR-25. WALDO CAVE (Sec.35, T.15S, R.21E, Ocala West Quad.). OCALA FAUNA (Marion), *Procambarus lucifugus* X *alachua* (Hobbs 1942), other cave-associated species. Private. REFERENCES: Franz 1982 (PlXa); Hobbs 1942*b* (PlXa); Hobbs et al. 1977 (PlXa); Peck 1970 (terrestrial arthropods); Warren 1961 (PlXa).

MAR-26. WELL (2 mi NE of Anthony) (Sec.9?, T.14S, R.22E, Anthony Quad.). OCALA FAUNA (Orange Lake?), *Crangonyx grandimanus* (JRH). Private.

MAR-27. WOODS CAVE (Sec.13, T.16S, R.21E, Shady Quad.). OCALA FAUNA (Marion), unidentified cave crayfishes. Private. REFERENCES: FSS files.

MAR-28. ZUBER SINK (Sec.9, T.14S, R.20E, Fairfield Quad.). OCALA FAUNA (Orange Lake?), unidentified cave crayfishes (JB). Private.

ORANGE COUNTY

ORA-1. APOPKA BLUE HOLE (Sec.16, T.20S, R.28E, Sorrento Quad.). ST. JOHNS RIVER FAUNA (Wekiva), *Procambarus acherontis* (USNM), *Troglocambarus* sp. (USNM). Private, vulnerable to urban development. REFERENCES: Hobbs III 1992 (Tsp, photo).

ORA-2. ROCK SPRINGS Sec.15, T.20S, R.28E, Sorrento Quad.). ST. JOHNS RIVER FAUNA (Wekiva), *Caecidotea* sp.2 (USNM). Public, Rock Springs County Park. REFERENCES: Auffenberg 1963 (fossils); Rosenau et al. 1977 (spring description); Webb 1974 (fossils).

ORA-3. WEKIWA SPRINGS (Sec.36, T.20S, R.28E, Forest City Quad.). ST. JOHNS RIVER FAUNA (Wekiva), *Procambarus acherontis* (USNM). Public, Wekiva Springs State Park, Florida Dept. Natural Resources. REMARKS: Cooper (1965*a*) noted that "white crayfish had been seen around 1890." The USNM specimen was collected in moss on the outside of one of the cracks in the main spring in about 1.5 meters water depth by David A. Sukkert on 29 September 1990 (Rosi Mulholland, personal communication, Florida Park Service). REFERENCES: Cooper 1965*a* (description); Rosenau et al. 1977 (spring description).

ORA-4. WELL, LONG LAKE (Sec.36, T.21S, R.28E, Orlando West Quad.). ST. JOHNS RIVER FAUNA (Wekiva), *Procambarus acherontis* (Franz and Lee 1982). Public, county water well. REFERENCES: Franz 1982 (Pa); Franz and Lee 1982 (Pa).

PASCO COUNTY

PAS-1. ARCH SINK (or Arch-Way Sink) (Sec.2, T.24S, R.17E, Port Richey NE Quad.). OCALA FAUNA (Gulf Coastal Lowlands), *Procambarus leitheuseri* (USNM). Private. REFERENCES: Franz and Hobbs 1983 (Ple).

PAS-2. BLACK HOLE (Sec.14, T.24S, R.16E, Aripeka Quad.). OCALA FAUNA (Gulf Coastal Lowlands), *Procambarus leitheuseri*

(USNM), other cave-associated species. Private. REFERENCES: Franz and Hobbs 1983 (Ple).

PAS-3. NEXUS SINK (Sec.3, T.25S, R.16E, Port Richey Quad.). OCALA FAUNA (Gulf Coastal Lowlands), *Crangonyx grandimanus* (JRH), *Crangonyx hobbsi* (JRH), *Procambarus leitheuseri* (USNM). Private. REFERENCES: Franz and Hobbs 1983 (Ple).

PAS-4. WELL, LACOOCHEE (unidentified site). OCALA FAUNA (Gulf Coastal Lowlands), *Crangonyx hobbsi* (JRH).

PINELLAS COUNTY

PIN-1. KNIGHT'S SINK (Sec.19, T.27S, R.16E, Elfers Quad.) OCALA FAUNA (Gulf Coastal Lowlands), unidentified cave crayfish (P. Heinerth, personal communication, 1984). Public, Anderson County Park, next to Tarpon Sink on west side of Lake Tarpon. REFERENCES: Wetterhall 1965 (hydrology).

PUTNAM COUNTY

PUT-1. DEVIL'S SINK (Sec.13, T.10S, R.23E, Interlachen Quad.). ST.JOHNS RIVER FAUNA (Oklawaha), *Uncinocythere ambophora* (Walton and Hobbs 1959), *Procambarus morrisi*-type locality (USNM), unidentified amphipods. Private, vulnerable to groundwater pollution from unauthorized dumping. REFERENCES: Hobbs and Franz 1990 (Pm, type description, Ua as commensal of Pm).

SEMINOLE COUNTY

SEM-1. PALM SPRING (Sec.2, T.21S, R.29E, Forrest City Quad.). ST. JOHNS RIVER FAUNA (Wekiva), *Uncinocythere ambophora*-type locality (USNM), *Procambarus acherontis* (USNM), other cave-associated species. Private, urban development. REMARKS: The Palm Springs basin (surface drainage area, 1.77 square miles) consists of Lake Marion, Eleven Hole Pond, and several small unconnected sinks (Anderson and Hughes 1975). The drainage area includes a golf course which is the probable location of the type locality of *Procambarus acherontis*. REFERENCES: Anderson and Hughes 1975 (hydrology); Cooper 1965*a* (spring description, Pa collection information); Franz 1982 (Pa); Hobbs 1940*a* (Pa redescription); Hobbs 1942*b* (Pa account); Hobbs et al. 1977 (Pa); Rosenau et al. 1977 (spring description); Walton and Hobbs 1959 (Ua, type locality); Warren 1961 (Pa).

SEM-2. WELL, ALTAMONTE SPRINGS (Sec.13, T.21S, R.29E, Casselberry Quad.). ST. JOHN RIVER FAUNA (Wekiva), *Procambarus acherontis* (RF). Private, urban. REFERENCES: Franz 1982 (Pa); Franz and Lee 1982 (Pa).

SEM-3. WELL, LAKE BRANTLEY (Sec.3, T.21S, R.29E, Forrest City Quad.). ST. JOHNS RIVER FAUNA (Wekiva), *Procambarus acherontis*-type locality (ZIAS). Private, urban. REMARKS: The *acherontis* specimens described by Einar Lonnberg were taken from a hand dug well on the farm of A. E. Sjoblom near Lake Brantley in 1893 (Lonnberg 1894). From land records in the Orange County Court House, we found that A. E. Sjoblom paid taxes on the following tracts in 1894. The land descriptions as found in the tax records are as follows: Plot 1. "Begins 573 feet north, 712 feet east of the SW corner of NW 1/4 (of Section 3), runs east 300 feet, north578 feet, west 300 feet, and south 578 feet." Plot 2. "Begins 4.5 chains west of SE corner of SW 1/4, of the NW 1/4, north 4.13 chains, west 1.21 chains, south 4.13 chains." (chain= 66 feet). This site is now located on a portion of the Sabal Point Golf Course. The owners and grounds people at the golf course knew of no open wells on the property, and we presume the well has been filled. RFERENCES: Faxon 1898; Franz 1982 (Pa); Hobbs 1940*a* (Pa, description), 1942*b* (Pa); Lonnberg 1894, 1895 (Pa, type description); Warren 1961 (Pa).

SUWANNEE COUNTY

SUW-1. ANDERSON SPRING (Sec.35, T.1S, R.11E, Falmouth Quad.). OCALA FAUNA (Upper Suwannee), unidentified cave crayfishes and amphipods (TM). Public, Florida state waters.

SUW-2. AZURE BLUE SINK (or Collins Farm Sink) (Sec.9, T.6S, R.15E, Hildreth Quad.). OCALA FAUNA (Upper Suwannee), *Procambarus erythrops* (USNM), *Troglocambarus maclanei* (USNM), unidentified cave amphipods (TM), other cave-associated species. Private. REFERENCES: Franz and Lee 1982 (Pe).

SUW-3. BLUE SINK (Sec.10, T.2S, R.15E, White Springs West Quad.). OCALA FAUNA (Upper Suwannee), unidentified cave amphipods (TM). Private.

SUW-4. BONNETT SPRING (Sec.20, T.4S, R.12E, Mayo Quad.). OCALA FAUNA (Upper Suwannee), *Procambarus pallidus* (ATL), unidentified cave amphipods (TM). Private. REFERENCES: Rosenau et al. 1977 (spring description).

SUW-5. BUFO SINK (Sec.24, T.6S, R.14E, Branford Quad.). OCALA FAUNA (Upper Suwannee), *Procambarus erythrops* (B. Sutton). Private. REMARKS: One of the sites mentioned by Releya and Sutton in the description of *Procambarus erythrops* (B. Sutton, personal communication, Gainesville, Florida). REFERENCES: Franz 1982 (Pe); Hobbs et al. 1977 (Pe); Relyea and Sutton 1975 (Pe).

SUW-6. CHALLENGE SINK (Sec.20, T.4S, R.12E, Dowling Park Quad.). OCALA FAUNA (Upper Suwannee), *Crangonyx hobbsi* (JRH), *Procambarus pallidus* (ATL). Public, Peacock Springs State Park, Florida Dept. Natural Resources.

SUW-7. CHARLES SPRING (Sec.4, T.4S, R.11E, Dowling Park Quad.). OCALA FAUNA (Upper Suwannee), *Procambarus pallidus*, unidentified cave amphipods (TM). Public, Suwannee County park.

SUW-8. CISTEEN SINK (Sec.21, T.4S, R.11E, Dowling Park Quad.). OCALA FAUNA (Upper Suwannee), *Crangonyx grandimanus* (JRH), *Crangonyx hobbsi* (JRH), *Procambarus pallidus* (USNM). Public, Peacock Springs State Park, Florida Dept. Natural Resources.

SUW-9. COW SPRING CAVE (Sec. 28, T.4S, R.12E, Dowling Park Quad.). OCALA FAUNA (Upper Suwannee), *Procambarus pallidus* (USNM), unidentified cave amphipods (TM). Private.

SUW-10. CRAZY HORSE SINK (Sec.21, T.4S, R.12E, Mayo Quad.). Mirkwood Sink Cave System. OCALA FAUNA (Upper Suwannee), *Procambarus pallidus* (USNM), unidentified cave amphipods (TM). Private.

SUW-11. DEBRIS CONE SPRING (Sec.9, T.4S, R.11E, Dowling Park Quad.). OCALA FAUNA (Upper Suwannee), unidentified cave crayfishes (TM). Private. REFERENCES: map (TM, J. Brown).

SUW-12. DEVIL'S HEAD AND HORNS (Sec.12, T.5S, R.13E, O'Brien SE Quad.). OCALA FAUNA (Upper Suwannee), cave-associated species. Private. REMARKS: Reportedly filled in (Julie Hovis, personal communication, Florida Game and Fresh Water Fish Commission, 1991). REFERENCES: Rice 1957 (bats).

SUW-13. DOUBLE SINK (Sec.16, T.5S, R.14E, O'Brien Quad.). OCALA FAUNA (Upper Suwannee), *Procambarus pallidus* (ATL). Private.

SUW-14. EDWARDS SPRING (Sec.24, T.1S, R.11E, Ellaville Quad.). OCALA FAUNA (Upper Suwannee), *Procambarus pallidus* (USNM), unidentified amphipods and isopods (TM). Private. REFERENCES: S. Exley (map)

SUW-15. FALMOUTH SPRING/SIPHON (or Cathedral Cave) (Sec.32, T.1S, R.12E, Falmouth Quad.). Falmouth Cave System. OCALA FAUNA (Upper Suwannee), *Procambarus pallidus* (ATL), unidentified amphipods (TM). Private. REFERENCES: Rosenau et al. 1977 (spring description), S. Exley (map).

SUW-16. GHOUL SINK (Sec.32, T.1S, R.12E, Falmouth Quad.). Falmouth Spring Cave System. OCALA FAUNA (Upper Suwannee), *Procambarus pallidus* (USNM). Private.

SUW-17. HILDRETH CAVE (Sec.16, T.6S, R.15E, Hildreth Quad.). OCALA FAUNA (Upper Suwannee), *Procambarus erythrops* (USNM). Private. REFERENCES: Relyea and Sutton 1975 (Pe).

SUW-18. IRVINE SLOUGH SPRING (Lauraville Spring) (Sec.24, T.4S, R.11E, Mayo Quad.). OCALA FAUNA (Upper Suwannee), *Procambarus pallidus* (ATL), unidentified cave amphipods and isopods. Private. REFERENCES: Rosenau et al. 1977 (spring description), TM (map).

SUW-19. LINEATER SPRING (Sec.7, T.1S, R.12E, Ellaville Quad.). OCALA FAUNA (Upper Suwannee), *Procambarus pallidus* (TM), unidentified cave amphipods (TM). Private.

SUW-20. LITTLE RIVER SPRING (Sec.1, T.6S, R.13E, Branford Quad.). OCALA FAUNA (Upper Suwannee), *Procambarus pallidus* (USNM), unidentified cave amphipods and isopods (TM), other cave-associated species. Public, Little River Springs County Park. REFERENCES: Franz and Lee 1982 (Pp); Rosenau et al. 1977 (spring description); Streever 1993 (invertebrates).

SUW-21. MIRKWOOD SINK (Sec.21, T.4S, R.11E, Mayo Quad.). OCALA FAUNA (Upper Suwannee), *Procambarus pallidus* (USNM). Private.

SUW-22. MULKY ROAD SINK (Sec.29, T.6S, R.15E, Hildreth Quad.). OCALA FAUNA (Upper Suwannee), cave-associated species (RF). Private.

SUW-23. O'HARA CAVE (Sec.24, T.1S, R.11E, Ellaville Quad.). OCALA FAUNA (Upper Suwannee), unidentified cave crayfishes (PS, 1977). Private.

SUW-24. OLSEN SINK (Sec.20, T.4S, R.11E, Dowling Park Quad.). Peacock Slough Cave System. OCALA FAUNA (Upper Suwannee), *Procambarus pallidus* (JB). Public, Peacock Springs State Park, Florida Dept. Natural Resources.

SUW-25. ORANGE GROVE SINK (Sec.20, T.4S, R.12E, Dowling Park Quad.). Peacock Slough Cave System. OCALA FAUNA (Upper Suwannee), *Crangonyx grandimanus* (JRH), *Crangonyx hobbsi* (JRH), *Procambarus pallidus* (USNM), other cave-associated species. Public, Peacock Springs State Park, Florida Dept. Natural Resources. REFERENCES: DeLoach and Arteaga 1972 (cave description); Rosenau et al. 1977 (spring description).

SUW-26. OSTEEN SINK (unidentified site). OCALA FAUNA (Upper Suwannee), *Procambarus pallidus* (USNM).

SUW-27. PEACOCK SLOUGH (unnamed cave in Peacock Slough Cave system) (Sec.20, T.4S, R.12E, Dowling Park Quad.). OCALA FAUNA (Upper Suwannee), *Procambarus pallidus* (USNM). Public, Peacock Springs State Park, Florida Dept. Natural Resources. REFERENCES: Hobbs 1971 (Pp); Hobbs et al. 1977 (Pp); Martin and Harris 1993 (mineralogy).

SUW-28. PEACOCK SPRING CAVE (Sec.20, T.4S, R.12E, Dowling Park Quad.). Peacock Slough Cave System. OCALA FAUNA (Upper Suwannee), *Remasellus parvus* (USNM), *Crangonyx grandimanus* (JRH), *Crangonyx hobbsi* (JRH), *Procambarus pallidus* (USNM), other cave-associated species. Public, Peacock Springs State Park, Florida Dept. Natural Resources. REFERENCES: Bowman and Sket 1985 (Rp); Exley and DeLoach 1981 (cave description); Exley and Fisk 1978 (cave description); Franz 1982 (Pp); Fisk and Exley 1977 (description); Rosenau et al. 1977 (spring description), Streever 1992*b* (crayfish kill).

SUW-29. PEACOCK SINK 3 (Sec.20, T.4S, R.12E, Dowling Park Quad.). Peacock Slough Cave System. OCALA FAUNA (Upper Suwannee), *Procambarus pallidus* (JB). Public, Peacock Springs State Park, Florida Dept. Natural Resources.

SUW-30. POT HOLE SINK (Sec.20, T.4S, R.12E, Mayo Quad.). Peacock Slough Cave System. OCALA FAUNA (Upper Suwannee), *Procambarus pallidus* (JB). Public, Peacock Springs State Park, Florida Dept. Natural Resources. REFERENCES: Rosenau et al. 1977 (spring description).

SUW-31. QUARRY SINK (Sec.23, T.6S, R.14E, Branford Quad.). OCALA FAUNA (Upper Suwannee), *Procambarus erythrops* (Franz 1982). Private. REMARKS: According to B. Sutton (personal communication), this was one of the unidentified localities where Relyea and Sutton found crayfishes during their surveys in preparation for the description of *Procambarus erythrops*. REFERENCES: Franz 1982 (Pe); Relyea and Sutton 1975 (Pe).

SUW-32. REGISTER SINK (Sec.17, T.5S, R.14E, O'Brien Quad.). OCALA FAUNA (Upper Suwannee), *Procambarus pallidus* (ATL). Private.

SUW-33. SANDBAG SPRING (Sec. 34, T.4S, R.12E, Mayo SE Quad.). OCALA FAUNA (Upper Suwannee), *Procambarus pallidus* (TM), unidentified cave amphipods (TM). Private.

SUW-34. SIM'S SINK (also Simm's Sink) (Sec.24, T.6S, R.14E, Branford Quad.). OCALA FAUNA (Upper Suwannee), *Crangonyx hobbsi* (JRH), *Procambarus erythrops*-type locality (USNM), *Troglocambarus maclanei* (USNM), unidentified cave isopods (TM). Private, The Nature Conservancy, cave crayfish preserve. REFERENCES: Franz 1982 (Ch, Pe, Tm); Franz and Lee 1982 (Pe); Hobbs et al. 1977 (Pe, Tm); Holt 1973*b* (Cl as commensal on Pe); Mellon 1977 (Pe, ocular response); Mellon and Lnenicka 1980 (Pe, ocular response); Relyea and Sutton 1975 (Pe, type description).

SUW-35. SMITH SINK (Sec. 20, T.5S, T.14E, O'Brien Quad.). OCALA FAUNA (Upper Suwannee), *Procambarus pallidus* (ATL). Private.

SUW-36. STICK SINK (Sec. 34, T.4S, R.14E, O'Brien Quad.). OCALA FAUNA (Upper Suwannee), *Procambarus pallidus* (ATL). Private.

SUW-37. SUWANNEE BLUE SPRING (Sec.1, T.4S, R.11E, Dowling Park Quad.). OCALA FAUNA (Upper Suwannee), unidentified cave amphipods (TM). Private.

SUW-38. TELFORD SPRING (or Tilford Spring) (Sec.25, T.4S, R.11E, Mayo Quad.). Luraville-Telford Spring System. OCALA FAUNA (Upper Suwannee), *Procambarus pallidus* (USNM). Private. REFERENCES: Knab 1991 (cave length); Martin and Harris 1993 (mineralogy); Rosenau et al. 1977 (spring description), Streever et al. 1993 (sediment deposition).

SUW-39. TEN MILE HOLLOW CAVE (Sec.35, T.4S, R.12E, Mayo SE Quad.). OCALA FAUNA (Upper Suwannee), *Procambarus pallidus* (TM). Private.

SUW-40. WATER HOLE 3 SINK (Sec.20, T.4S, R.12E, Mayo Quad.). Peacock Slough Cave System. OCALA FAUNA (Upper Suwannee), *Procambarus pallidus* (JB). Public, Peacock Springs State Park, Florida Dept. Natural Resources.

SUW-41. WATERING HOLE SPRING (Sec.9, T.4S, R.11E, Dowling Park Quad.). OCALA FAUNA (Upper Suwannee), unidentified cave crayfishes and amphipods (TM). Private.

SUW-42. WINGATE WELL (Sec.23, T.5S, R.13E, Mayo SE Quad.). OCALA FAUNA (Upper Suwannee), unidentified cave cray-fishes, amphipods, and isopods (TM). Private.

SUW-43. YUCK SPRING (Sec. 22, T.4S, R.11E, Dowling Park Quad.). OCALA FAUNA (Upper Suwannee), unidentified cave cray-fishes, amphipods, and isopods (TM). Private.

WAKULLA COUNTY

WAK-1. EMERALD SINK (Sec.20, T.2S, R.1W, Lake Munson Quad.). Emerald Sink Cave System. WOODVILLE FAUNA, *Crangonyx hobbsi* (JRH), *Crangonyx grandimanus* (JRH), *Procambarus orcinus* (USNM). Public, Apalachicola National Forest, U.S. Forest Service. REFERENCES: Exley and Goodman 1981 (cave description, map).

WAK-2. INDIAN SPRINGS (Sec.3, T.3S, R.1W, Crawfordville Quad.). WOODVILLE FAUNA, *Procambarus orcinus* (USNM). Private. REFERENCES: Rosenau et al. 1977 (spring description); Exley and Goodman 1981 (cave description).

WAK-3. MCBRIDE SLOUGH SPRING (Sec.7, T.3S,. R.1E, Crawfordville Quad.). Wakulla Springs Cave System. WOODVILLE FAUNA, *Crangonyx grandimanus* (JRH), *Crangonyx hobbsi* (JRH),

Procambarus orcinus (USNM), unidentified cave amphipods and isopods (Morris 1989). Private. REFERENCES: Morris 1989 (Po).

WAK-4. RIVER SINKS (Sec.28, T.2S, R.1W, Lake Munson Quad.). Emerald Sink Cave System. WOODVILLE FAUNA, *Crangonyx* sp. (JRH), *Crangonyx hobbsi* (JRH), *Procambarus orcinus* (Caine 1978). Private. REFERENCES: Caine 1978 (Po, ecology); Rosenau et al. 1977 (spring description); Exley and Goodman 1981 (map).

WAK-5. SALLY WARD SPRING (or Numero Uno Spring) (Sec.11, T.3S, R.1W, Crawfordville Quad.). Wakulla Springs Cave System. WOODVILLE FAUNA, *Crangonyx* sp. (JRH), *Crangonyx hobbsi* (JRH), *Procambarus orcinus* (Morris 1989). Public, Wakulla Springs State Park, Florida Dept. Natural Resources. REFERENCES: Morris 1989 (Po, photo); Wilson and Sparks 1992 (hydrology).

WAK-6. SHEPARD BLUE SPRING (Land Grant Sec. 99, Hartsfield Survey, Spring Creek Quad.). WOODVILLE FAUNA, *Crangonyx grandimanus* (JRH), *Crangonyx hobbsi* (JRH), *Procambarus horsti* (USNM). Public, state waters. REFERENCES: Rosenau et al. 1977 (spring description).

WAK-7. SPLIT SINK (Sec.20, T.2S, R.1W, Lake Munson Quad.). Emerald Sink Cave System. WOODVILLE FAUNA, *Remasellus parvus* (USNM). Public, Apalachicola National Forest, U.S. Forest Service. REFERENCES: Exley and DeLoach 1981 (cave description, map); Bowman and Sket 1985 (Rp, generic description); Exley and Goodman (map).

WAK-8. WAKULLA SPRINGS (Sec.11, T.3S, R.1W, Crawfordville Quad.). Wakulla Springs Cave System. WOODVILLE FAUNA, *Procambarus orcinus* (USNM), *Procambarus horsti*(?) (Morris 1989), unidentified cave amphipods and isopods (Morris 1989). Public, Wakulla Springs State Park, Florida Dept. Natural Resources. REFERENCES: DeLoach et al. 1989 (description); Franz 1982 (Po); Hobbs et al. 1977 (Po); Hobbs and Means 1972 (Po); Lane 1986 (cave description); Mohr 1964 (fossils); Morris 1989 (Po); Olsen 1958; Rosenau et al. 1977 (spring description); Rupert 1991 (geology); Rupert and Wilson 1989 (geology and hydrology); Skiles 1989 (cave description); Webb 1974 (fossils).

WASHINGTON COUNTY

WAS-1. ECONFINA BLUE SPRING CAVE (Sec.27, T.1N, R.13W, Bennett Quad). ECONFINA CREEK FAUNA, *Caecidotea* sp.1 (JL), *Dasyscias franzi*-type locality (UF), other cave-associated species. Private. REFERENCES: Rosenau et al. 1977 (spring description); Thompson and Hershler 1991 (Df, type description).

WAS-2. FALLING WATERS TRAIL CAVE (Sec.27, T.4N, R.13W, Wausau Quad.). APALACHICOLA FAUNA (?), cave-associated species. Public, Falling Waters State Park, Florida Dept. Natural Resources. REFERNCES: Franz et al. 1971 (snails); Lane 1986 (map).

DECATUR COUNTY, GEORGIA

DEC-1. CLIMAX CAVE (3 mi N of Climax). APALACHICOLA FAUNA (SW Georgia), *Uncinocythere warreni*-type locality (USNM), *Cambarus cryptodytes* (USNM), *Haideotriton wallacei* (UF). Private. REFERENCES: Beck and Arden 1984 (geology, cave map); Hobbs 1981 (Cc account); Hobbs and Walton 1968 (Uw, type description); Hobbs et al. 1977 (Cc); Maddox 1992 (radon concentrations); Warren 1961 (Cc, Hw).

DOUGHERTY COUNTY, GEORGIA

DOU-1. WELL, ALBANY (unidentified site). APALACHICOLA FAUNA (SW Georgia), *Haideotriton wallacei*-type locality (MCZ). Private. REFERENCES: Carr 1939 (Hw, type description).

The Chonaphini, a Biogeographically Significant Milliped Tribe in Eastern and Western North America (Polydesmida: Xystodesmidae)

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ABSTRACT—The Chonaphini, the only Nearctic xystodesmid tribe represented in both the eastern and western faunal regions, is the only tribe in the family in which the prefemoral process is typically more complex and of greater taxonomic utility than the acropodite. The latter structure varies from narrowly blade-like to acicular, and excepting *Montaphe paraphoena*, n.sp., lacks secondary projections. The prefemoral process, however, is often elaborate with secondary structures arising from the stem. Six genera, three monotypic, and twelve species comprise the tribe, with *Semionellus* Chamberlin and *S. placidus* (Wood) inhabiting four areas in the eastern United States from southeastern Minnesota to westcentral Virginia. The other taxa occur west of the Continental Divide from Montana to north-central California and Vancouver Island, Canada. *Chonaphe* Cook is represented by two new and two established species in the United States, *C. evexa* and *schizoterminalis*, and *C. remissa* Chamberlin and *armata* (Harger). *Chonaphe cygneia* and *patriotica*, both authored by Chamberlin, and *C. serratus* Loomis and Schmitt are placed in synonymy under *C. armata*. *Montaphe elrodi* (Chamberlin), the dominant xystodesmid from eastern Washington to western Montana, is projected to occur in the southern extremity of central British Columbia adjacent to Idaho and northeastern Washington. *Metaxycheir* Buckett and Gardner and *Tubaphe* Causey are monotypic, *M. prolata* Buckett and Gardner occurring in eastern Washington and the adjoining part of northern Idaho, and the subcylindrical *T. levii* Causey occurring in wet rainforests of the Olympic Mountains and the southwestern corner of Vancouver Island. *Selenocheir* n. gen., characterized by a short prefemoral process less than half as long as the acropodite, consists of three new species ranging from southwestern Oregon to the northern California coast and the northern Sierra Nevada Mountains. Modern descriptions and illustrations are presented for all tribal taxa along with keys to genera and to the species of *Chonaphe* and *Selenocheir*.

The milliped family Xystodesmidae, the dominant Nearctic polydesmoid family, occurs in three general regions of the continent: the eastern United States and southern Ontario and Quebec, Canada, east of the Central Plains; from southern Texas and New Mexico to El Salvador; and along the Pacific Coast west of the Sierra Nevada and Cascade Mountains from Los Angeles to southern Alaska, with an eastward extension into western Montana (Shelley 1987). The family is also well represented in east Asia—Japan, the Riu Kiu Archipelago, Korea, the vicinity of Vladivostok, Russia, and an unknown area in central China (Hoffman 1978, 1979). Tribal continuity exists between Meso-America and the eastern Nearctic, as the Rhysodesmini, the only Meso-American tribe, is represented in eastern North America by 9 genera and over 20 species. Similarly, the Orophini and Harpaphini are represented in both the western Nearctic and Asiatic regions. There

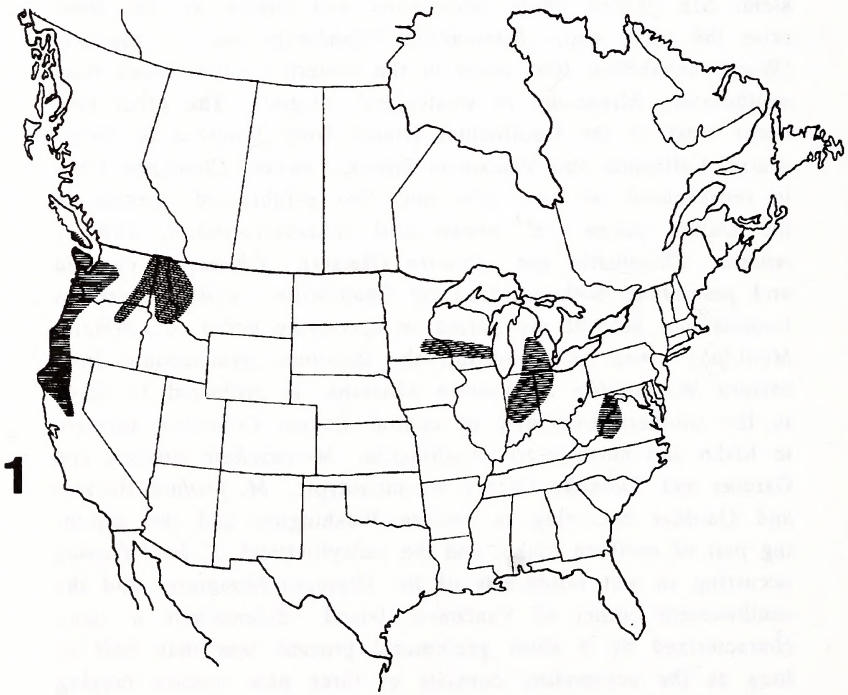


Fig. 1. Distribution of the Chonaphini. A smooth curve is drawn around range extremes in all directions. Though no records are available from the interior of British Columbia, the western interior region shows the projected occurrence of *M. elrodi* near the border with Idaho and northeastern Washington.

are no faunal linkages between the western Nearctic and Meso-America, and the Chonaphini is the only common tribe between the West and East.

The Chonaphini occurs primarily in the western United States and Vancouver Island, Canada (Fig. 1), where there are currently 5 genera and 11 nominal species (Shelley 1990, 1993*a*). West of the Columbia Plateau, *Tubaphe levii* Causey inhabits rainforests of the Olympic Mountains and Vancouver Island, and *Chonaphe armata* (Harger) and *C. remissa* Chamberlin occur sporadically in western Oregon and Washington, respectively (Shelley 1990, 1993*b*). In the western interior, the tribe is represented by *Montaphe elrodi* (Chamberlin), the dominant xystodesmid from eastern Washington to western Montana, *C. armata*, also occurring sporadically in western Montana, northern Idaho, and northeastern Oregon and Washington, and *Metaxycheir prolata* Buckett and Gardner, localized in Latah and Benewah counties, Idaho, and the adjacent eastern periphery of Whitman County, Washington (Buckett and Gardner 1969, Shelley 1990). I place three additional nominal species—*C. cygneia* and *patriotica*, both authored by Chamberlin, and *C. serratus* Loomis and Schmitt—in synonymy under *C. armata*. East of the Central Plains, the Chonaphini is represented by *Semionellus placidus* (Wood), which occurs primarily in three general areas: from southeastern Minnesota to eastern Wisconsin, from central Michigan to western Indiana, and from western Maryland to westcentral Virginia (Shelley 1990).

In addition to its biogeographic significance as a trans-Nearctic taxon, the Chonaphini is unique in that it reverses the basic anatomical pattern of the family. In other xystodesmid tribes, the gonopodal acropodite possesses most diagnostic features and is often elaborate, whereas the prefemoral process is variable but generally simple and with little taxonomic utility. In the Chonaphini, however, the acropodite is typically the simple structure, while the prefemoral process is usually larger and often elaborate, displaying flanges and other projections from its stem. The prefemoral process is thus the dominant feature of most chonaphine gonopods and exhibits most taxonomic characters. Indeed, the acropodite, usually a curved acicular to narrowly blade-like projection, is so thin and fragile in most species that it is easily broken during dissection, so care is needed to remove a gonopod with this structure intact.

With these basic attributes of the prefemoral process and acropodite, the Chonaphini seems at first to be a coherent assemblage whose study is comparatively straightforward, but there are undescribed forms that depart from this pattern, cannot be accommodated by other western

tribes, and appear to relate to known chonaphines. One species, *Montaphe paraphoena*, n. sp., occurring on the western periphery of the Columbia Plateau in central Washington, has a modified acropodite that expands distad and possesses a secondary projection. These features lend taxonomic utility to the acropodite and suggest that additional forms with expanded, modified acropodites, await discovery in central Washington. Because of similarities with *M. elrodi* in coloration and the curvature patterns of the telopodal elements, I provisionally assign this species to *Montaphe* instead of erecting a fifth monotypic genus, although this action necessitates a broad generic diagnosis resulting in a heterogeneous taxon. Furthermore, *Selenocheir*, n. gen., with three species in southern Oregon and northern/central California, is assigned to the Chonaphini even though it has a short prefemoral process that is less than half the length of the acropodite. The latter structure conforms to the tribal diagnosis in being narrowly blade-like to acicular, but differences in its orientation on the prefemur, in the broadness of its arc, and in the distal configuration again lend it taxonomic utility. This genus is more compatible with the Chonaphini than with any other western xystodesmid tribe, and traits of the prefemoral process and acropodite appear to represent plesiomorphic conditions that bridge anatomical gaps with the Harpaphini.

Thus the Chonaphini, which appears to be a homogeneous assemblage characterized by a narrow, unmodified acropodite and a long, elaborate prefemoral process, is really a highly variable ensemble with few consistent, unifying features; even the structures of the cyphopods and the configurations of the gonopodal apertures vary widely. *Tubaphe* and *Selenocheir* also lack a gonosternum, the coxae being attached by membrane only, and those taxa with a sclerotized band differ in the position of the sternal lobes. For example in *M. elrodi*, the sternum is short, resulting in narrowly segregated gonopods, and there are small lateral lobes subtending the coxae; in *M. paraphoena* the sternum is also short and the gonopods are narrowly separated, but there is an elongated medial lobe instead of two lateral ones. The Chonaphini, therefore, is not united by a few features shared by all included taxa but by a number of traits that are shared unevenly among the components such that only one higher category can be defined to encompass the scope of this variation. Efforts to divide the group and render it more homogeneous by splitting off dissimilar forms like *Tubaphe* and *Selenocheir*, which lack a gonosternum, or just the latter, which has the short prefemoral process, or *M. paraphoena*, with the medial sternal lobe and an expanded, modified acropodite, result in undefinable categories that cannot be contrasted with a recon-

stituted tribe Chonaphini. The chonaphine taxa therefore relate through differentially shared aspects of all the principal features; two forms that do not share one attribute share others, or relate through a third form with which they share still other features.

Separate taxonomic status for this assemblage was first proposed by Verhoeff (1941), who established the Chonaphinae as a subfamily in the "Leptodesmidae." Hoffman (1979) reduced the taxon to tribal status and listed *Chonaphe* Cook, *Montaphe* Chamberlin, *Semionellus* Chamberlin, and *Metaxycheir* Buckett and Gardner as component genera. He and I (Shelley 1990) placed *Tubaphe* Causey in the Harpaphini, an understandable misassignment because one gonopod of the holotype of *T. levii* Causey is lost, the other is broken, and the descriptive accounts and illustrations (Causey 1954*a*) do not begin to portray the taxonomically important features. I (Shelley 1990) proposed *Metaxycheir pacifica* for a chonaphine on Vancouver Island, British Columbia, that I subsequently (Shelley 1993*a*) had to place in synonymy under *T. levii* after recollecting the latter in the Olympic Mountains. Despite the unfortunate proposal of a synonym, my description and illustrations (Shelley 1990) make *T. levii* the only chonaphine taxon that has been characterized in accordance with modern standards. Most were proposed with terse accounts that merely validated the names, and one new genus and six new species await description. The purpose of this contribution, therefore, is to present modern descriptions and illustrations for all chonaphine taxa except *T. levii*, where such is provided in the account of *M. pacifica* (Shelley 1990). Acronyms of sources of preserved study material are as follows:

AMNH—American Museum of Natural History, New York, New York.
BYU—Monte L. Bean Life Science Museum, Brigham Young University, Provo, Utah.
CAS—California Academy of Science, San Francisco.
CMN—Canadian Museum of Nature, Ottawa, Ontario.
EIL—Zoology Department, Eastern Illinois University, Charleston.
FMNH—Field Museum of Natural History, Chicago, Illinois.
FSCA—Florida State Collection of Arthropods, Gainesville.
MCZ—Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts.
MPM—Milwaukee Public Museum, Milwaukee, Wisconsin.
NCSM—North Carolina State Museum of Natural Sciences, Raleigh.
NMNH—National Museum of Natural History, Smithsonian Institution, Washington, D. C.

PMNH—Peabody Museum of Natural History, Yale University, New Haven, Connecticut.
RBCM—Royal British Columbia Museum, Victoria, British Columbia, Canada.
ROM—Royal Ontario Museum, Toronto, Ontario, Canada.
SDMNH—San Diego Museum of Natural History, San Diego, California.
TMM—Texas Memorial Museum, University of Texas, Austin.
UBC—Zoology Department, University of British Columbia, Vancouver, British Columbia, Canada.
UCD—Bohart Entomological Museum, University of California at Davis.
UMN—Entomology Department, University of Minnesota, St. Paul.
UWBM—Thomas Burke Washington State Museum, University of Washington, Seattle.
UWY—University of Wyoming Insect Museum, Laramie.
VMNH—Virginia Museum of Natural History, Martinsville.
WAS—Private collection of William A. Shear, Hampden-Sydney, Virginia.
WSU—James Entomological Museum, Washington State University, Pullman.
WU—Biology Department, Willamette University, Salem, Oregon.

LITERATURE REVIEW

The subfamily Chonaphinae was proposed by Verhoeff (1941) for *Chonaphe*, which was erected by Cook (1904) for *Polydesmus armatus*. This species was one of four myriapods that Harger (1872) described from an unspecified site along the John Day River, Oregon, which I (Shelley 1993*b*) inferred was near Canyon City, Grant County, on the western slope of the Blue Mountains. The third xystodesmid to be named from western North America, after *P.* (*Leptodesmus*) *haydenianus* Wood (1864), now in *Harpaphe*, and *P. dissectus* Wood (1867), now in *Motyxia*, *C. armata* is also the second oldest chonaphine species behind *P.* (*L.*) *placidus*, described by Wood (1864) from an unspecified site in Michigan. Immediately following the latter's description, Wood (1864) proposed the synonym, "*P.* (*L.*) *floridus* var.?," and Wood (1865) repeated the accounts of both species, providing a gonopod illustration of the former.

Sixteen years after Harger's work, Bollman (1888) recorded *L. placidus* from Boswell, Benton County, Indiana. In a listing of North American myriapods, Bollman (1893) included *L. armatus* and

placidus, placed *P. floridus* var.? in synonymy under the latter, and described *L. borealis* from Winona, Winona County, Minnesota. Kenyon (1893*a*, *b*) reported *L. floridus*, misspelled as "*floriaius*" in the first work, from four towns in Nebraska, as did Gunthorp (1913) from Jefferson County, Kansas, which Cragin (1885) previously recorded as *P. floridus*. Because these sites are well removed from the range of *S. placidus*, Shelley (1989) concluded that the usages refer to eurymerodesmids and placed the names in synonymy under species of *Eurymerodesmus*.

The first reference to a chonaphine in the present century was by Carl (1903), who redescribed *L. placidus*. Cook (1904) erected *Chonaphe* and assigned the new combination, *C. armata*, to a specimen from an unspecified site in Washington. Chamberlin (1911) recorded *L. armatus* from Madison, Washington, probably a misspelling of Madson, Whitman County, a now non-existent community not far from Viola, Latah County, Idaho. Chamberlin (1913) described *L.* (*C.*) *elrodi* from Flathead Lake, Montana, and in a statement in an introductory paragraph of a paper on an unrelated polydesmoid, he (Chamberlin 1920) proposed *Semionellus* and designated *L. placidus* as the type species. Apparently unaware of this action, Williams and Hefner (1928) recorded *L. placidus* from Allen, Hardin, Wood, and Seneca counties, Ohio. Attems (1938) published anatomical treatments and illustrations of *C. armata*, "*Trichomorpha*" *placida*, and "*Amphelictogon*" *elrodi*, but his (Attems 1931) account and illustrations of *C. armata* from a farm near Olympia, Thurston County, Washington, clearly refer to *C. remissa*, described by Chamberlin (1949). Consequently, his 1938 treatment of *C. armata* is really of both congeners.

After Verhoeff (1941) erected the Chonaphinae, Chamberlin (1946) described *C. michigana*, from Midland County, Michigan, and two years later (Chamberlin 1948), transferred this species to *Semionellus*. In the latter paper, he also described and illustrated *S. tertius*, from Kerrville, Kerr County, Texas, and in the previous year, he (Chamberlin 1947) recorded *S. placidus* from Garrett County, Maryland. Chamberlin (1949) transferred *L.* (*C.*) *elrodi* into the new genus, *Montaphe*, and described three new species of *Chonaphe*: *C. cygneia*, from White Swan, Yakima County, Washington; *C. patriotica*, from Fourth of July Canyon, Kootenai County, Idaho; and *C. remissa*, from Puyallup, Pierce County, Washington. Chamberlin (1951) recorded *S. placidus* from Fort Benning, Chattahoochee/Muscogee counties, Georgia, a misidentification of the introduced paradoxosomatid *Oxidus gracilis* (Koch), as noted by Shelley (1990). Causey (1952) recorded *Trichomorpha placida* from Dane and Milwaukee counties, Wisconsin, and a cave in

Union County, Illinois. Causey (1954*a*) erected *Tubaphe* for *T. levii*, from the Olympic rain forest, Jefferson County, Washington, and (Causey 1954*b*) recorded *M. elrodi* from Evans, Stevens County, Washington. Johnson (1954) included *S. placidus* among his list of Michigan millipeds but gave no specific localities. Chamberlin and Hoffman (1958) listed all species recognized at that time, added New York and Virginia to the range of *S. placidus*, placed *L. borealis* and *S. michigana* in synonymy, and transferred *S. tertius* into the chelodesmid genus *Aphelidesmus*, where it clearly belongs. Its purported occurrence in Texas can only reflect a labelling error, as the genus otherwise occurs from Costa Rica southward (Hoffman 1979).

Little has appeared on the Chonaphini in recent years. Hoffman (1969) noted that *Semionellus* is monotypic, related to *Chonaphe* and *Montaphe*, and cited its range as being from Minnesota to Illinois and Ohio, with isolated populations in western Maryland, the adjacent part of West Virginia, and the Virginia Blue Ridge. Buckett and Gardner (1969) erected *Metaxycheir* for *M. prolata*, occurring near Moscow, Latah County, Idaho, which they erroneously recorded as Nez Perce County. They correctly related *Metaxycheir* to *Chonaphe*, but apparently unaware of Verhoeff's subfamily, placed these genera, along with *Harpaphe* Cook and *Hybaphe* Cook, in the Orophinae, erected by Hoffman (1964) to accommodate *Orophe* Chamberlin and *Pamelaphe* Hoffman. This heterogeneous taxon was disassembled by Hoffman (1979), who transferred *Harpaphe* and *Hybaphe* to the new tribe Harpaphini and reduced the Chonaphinae and Orophinae to tribal status. Loomis and Schmitt (1971) described the final nominal species, *C. serratus*, from Sanders and Lake counties, Montana, alluded to the occurrence of *C. armata* along Puget Sound, Washington, where the only congener is *C. remissa*, and reported numerous new records of *M. elrodi* from Lake, Missoula, and Sanders counties, Montana, and Idaho County, Idaho.

The final relevant works concern Canada. Kevan (1983) listed all the taxa as potential Canadian inhabitants, and Shelley (1990) described *Metaxycheir pacifica* from Vancouver Island and summarized the distribution of the tribe and its generic and specific composition, omitting *Tubaphe* and *T. levii*. Shelley (1993*a*) synonymized *M. pacifica* under *T. levii* after recollecting the latter in the Olympic Mountains.

Thus, at this writing, five genera and nine species comprise the Chonaphini. They are listed chronologically below along with type localities and other reported occurrences.

Chonaphe Cook, 1904.

C. armata (Harger 1872). Vicinity of Canyon City, Grant County, Oregon, as deduced by Shelley (1993*b*). Also recorded from Washington in general (Cook 1904, Attems 1938); and the Puget Sound area (Loomis and Schmitt 1971); Oregon (Attems 1938, Chamberlin and Hoffman 1958); Idaho (Attems 1938); Madson (misspelled as Madison), Whitman County, Washington (Chamberlin 1911); near Olympia, Thurston County, Washington (Attems 1931); and Benton, Clackamas, and Multnomah counties, Oregon; King, Chelan, Kittitas, and Stevens counties, Washington; Latah and Clearwater counties, Idaho; and Lincoln and Missoula counties, Montana (Shelley 1990).

C. cygneia Chamberlin 1949. White Swan, Yakima County, Washington.

C. patriotica Chamberlin 1949. Fourth of July Canyon, Kootenai County, Idaho.

C. remissa Chamberlin 1949. Puyallup, Pierce County, Washington.

C. serratus Loomis and Schmitt 1971. 1.0 mi (1.6 km) west of Noxon, Sanders County, Montana. Also recorded from 4.0 mi (6.4 km) west of Noxon and 2.0 mi (3.2 km) north of Yellow Bay, Lake County, Montana.

Semionellus Chamberlin, 1920.

S. placidus (Wood 1864). Michigan without further specification. Also recorded from Minnesota, Illinois, and Ohio (Hoffman 1969); Michigan (Wood 1865, Attems 1938, Johnson 1954); New York and Virginia (Chamberlin and Hoffman 1958); western Maryland and adjacent West Virginia (Hoffman 1969); the Virginia Blue Ridge (Hoffman 1969); Winona, Winona County, Minnesota (Bollman 1893); Dane and Milwaukee counties, Wisconsin (Causey 1952); Union County, Illinois (Causey 1952); Midland County, Michigan (Chamberlin 1946); Boswell, Benton County, Indiana (Bollman 1888); and Allen, Hardin, Wood, and Seneca counties, Ohio (Williams and Hefner 1928).

Montaphe Chamberlin, 1949.

M. elrodi (Chamberlin 1913). Flathead Lake, Lake/Flathead counties, Montana. Also recorded from Evans, Stevens County, Washington (Causey 1954*b*, Shelley 1990); Spokane and Whitman counties, Washington (Shelley 1990); Lowell, Idaho County, Idaho (Shelley 1990) and 3.1 mi (5.0 km) west of Surveyor Creek, Idaho County (Loomis and Schmitt 1971); Clearwater and Shoshone counties, Idaho (Shelley 1990); and numerous localities in Lake, Missoula, and Sanders counties, Montana (Loomis and Schmitt 1971).

Tubaphe Causey, 1954*a*.

T. levii Causey (= *Metaxycheir pacifica* Shelley). Graves Creek

Campground, Olympic National Park, Jefferson County, Washington. Also known from Port Renfrew and seven other sites along the Pacific Coast in the southwestern corner of Vancouver Island, British Columbia, Canada (Shelley 1990).

Metaxycheir Buckett and Gardner, 1969.

M. prolata Buckett and Gardner. 7 mi (11.2 km) northeast of Moscow, Latah County, Idaho. Also known from Laird Park, cited as Laird "Peak," 3.0 mi (4.8 km) southeast of Harvard, Latah County (Shelley 1990).

ANATOMY AND TAXONOMIC CHARACTERS

Color—The overall "rust" colored appearance distinguishes species of *Montaphe* from sympatric xystodesmids of all tribes—Orophini, Harpaphini, and Chonaphini—and I have even noticed a tinge of this pigmentation in dried specimens that have been out of alcohol for years. I characterize the color as "rust" because it is a muted or dampened red, as if mixed with a touch of brown, as opposed to the bright red of Appalachian species of *Sigmoria* (Shelley and Whitehead 1986). The rust color seems characteristic of the genus, as the pigment was clearly evident in the type series of *M. paraphoena* after 1 1/2 years in preservative. The color is actually restricted to the paranota and concolorous bands along the caudal margins of each metatergite, but the latter are so broad as to cover most of the metazona and dominate the organism. Although one notices the dark gray to black base color, the rust pigmentation overwhelms one's senses and identifies the milliped as a representative of *Montaphe*.

The red banded pattern of *Semionellus placidus* is less distinctive than the color of *Montaphe* spp., but in its range, *S. placidus* is about the only xystodesmid displaying this color. An occasional specimen of *Sigmoria* (*Rudiloria*) spp. may show reddish stripes, but this pattern is exhibited primarily by congeners to the south in the Carolinas, Tennessee, and Georgia (Shelley and Whitehead 1986). Yellow is the dominant color in the forms of *Sigmoria*, *Apheloria*, and *Brachoria* that are sympatric with *S. placidus*.

Body Form and Somatic Features—*Tubaphe levii* and *S. placidus* are readily identified by their general body forms. As noted by Shelley (1990), the unmistakable, nearly julidan appearance of the caudal 2/3 of its body, caused by the absence of paranota caudal to segment 4 (Fig. 45), instantly distinguishes *T. levii* from sympatric specimens of *Harpaphe h. haydeniana*. Though less distinctive, the generally subcylindrical body form, caused by reduced and declined paranota, also distinguishes *S. placidus* from the much broader and more robust

sympatric representatives of the Apheloriini and Rhysodesmini. Combining body form with color pattern allows one to unfailingly recognize *S. placidus* in the field.

Aside from the size and degree of decline of the paranota, there are few noteworthy aspects of the somatic details. The epiproct of *T. levii* displays a narrow constriction (see Causey 1954*a*, fig. 2), whereas those of the other taxa are smoothly subtriangular. Low lateral ridges subtend the anterior coxae, and the glaborous pregonopodal sterna, depressed on segment 6 and the caudal half of segment 5 to accommodate the gonopodal telopodites, generally lack modifications aside from long, diverging projections on the 4th sternite of *S. placidus* (Fig. 27). The postgonopodal sterna also are glabrous and unmodified, with only shallow transverse grooves between the leg pairs and gently curved caudal margins. The pregonopodal coxae of *Metaxycheir prolata* are swollen with slight anteriorly directed lobes but are unmodified in other species. Prefemoral spines are present in all species, but only on postgonopodal legs and often only in the caudal half of the body.

Aperture—The aperture in the Chonaphini usually extends caudad to at least a small degree in the midline. The only exceptions are *T. levii* and *Chonaphe evexa*, which resemble other northwestern xystodesmids in lacking even a trace of a caudal extension (Figs. 15, 46). This feature of the aperture is particularly noticeable in *C. armata* and *S. placidus* (Figs. 2, 28), which have long, broad extensions, and is another trait that distinguishes the latter from sympatric representatives of other eastern tribes. Within these extensions is a sclerotized ledge or shelf that I believe represents the sternum between the 9th legs. Thus, it is really only the elevated caudal margin that extends or "peels" caudad, analogous to "peeling" the backing off a gummed label; the opening itself is ovoid to elliptical. However, in *C. armata* and *S. placidus*, the extensions are so obvious as to appear a functional part of the opening even though they are not.

Gonopods—As stated previously, the Chonaphini is unique in that the prefemoral processes are highly variable and possess most taxonomically important features, whereas the acropodites are simple and with little taxonomic utility, as opposed to the reverse in all other xystodesmid tribes. All genera and most species can be diagnosed from aspects of the prefemoral process, which is the dominant gonopodal feature, overshadowing the acropodite in most forms. The arrangements of the telopodal elements relative to each other are also important, the prefemoral process and acropodite being subparallel in *Semionellus* and *Montaphe*, and not parallel in the other genera. It is this shared

parallel arrangement coupled with the shared rust color that support placement of *paraphoena* in *Montaphe* along with *elrodi*.

Prefemoral Process—There are three basic types of prefemoral processes: the short projections of *Selenocheir* that are less than half as long as the acropodites (Figs. 54–55, 60–61, 65–66); long ones, as long or longer than the acropodite, that are narrowly blade-like to subacicular (Figs. 35–38, 47–48, 52–53); and long ones that are expanded, broad, and laminate (Figs. 3–7, 10–13, 16–19, 22–25, 30–31). The distally expanded, trifurcate projection of *Montaphe paraphoena* (Figs. 42–43), shorter than the acropodite, is an exception. The massive structures of *Chonaphe* and *Semionellus* are especially lamellate distad. In *Chonaphe*, the projection is upright and expands at about 1/3 length into a narrow shelf or ledge on the dorsal side. The outer margin of the ledge extends distad a short distance as a translucent shield; in *C. schizoterminalis* a distal angular flap on the stem of the prefemoral process overlaps the shield to form a tube; and in *C. remissa* the shield connects to the inturned lateral margin of the stem to form a continuous lamina that extends to the tip of the process. The distal part of the acropodite inserts onto this shield or through the tube and extends for varying lengths, emerging from behind the shield and becoming visible in medial view in *C. armata* and *evexa* (Fig. 5), while being obscured by the continuation of the shield and its linkage with the inturned lateral margin in *C. remissa* (Fig. 11). Distal to the shelf, there is the flap of *C. schizoterminalis* (Fig. 23), a low angular ridge in *C. evexa* (Fig. 18), and a thickened, convoluted projection in *C. armata* and *remissa* about halfway between the ledge and the tip (Figs. 5–6, 11–12). Taxonomically, the most important aspect of the prefemoral process of *Chonaphe* is the apical configuration, which is a modification of a basically subdivided structure. In *C. schizoterminalis*, the tip is deeply divided lateral to the midline into two apical projections, a narrow, lateral, dactyliform branch that is subequal in length to the larger, medial branch (Figs. 22–24). The process is apically entire in *C. evexa*, but the subterminal lateral margin turns inward for a short distance to form a narrowly rounded lobe, suggesting an apical division that has become subapical as the apical-medial margin has enlarged and expanded (Figs. 18–19). The impression that I receive from *C. armata* and *remissa* is of formerly divided apices that have rejoined, with the suture line still being evident in the latter, particularly when viewed in ventral perspective (Fig. 13). In both species, it is as if a previous division has disappeared, leaving a vertical, coaxial flap or sclerotized, marginally serrate lamella in *C. remissa* (Figs. 10–12), and an inturned, subacuminate, transverse medial corner in *C. armata*

(Figs. 4–6). Thus, although taxonomically important features occur on several parts of the prefemoral process, all four species of *Chonaphe* can be diagnosed solely from the apical configuration. It seems ironic that such significance can accrue to such a minute part of this massive structure.

Though large, expanded, and laminate, the prefemoral process of *Semionellus* (Figs. 30–31) has a different configuration from that of *Chonaphe*. Instead of being upright, it bends strongly, at about a right angle, near 1/3 length and exhibits cupulate flanges on the medial surface proximal and distal to this bend. There is no ledge or shield as in *Chonaphe*, but occasionally the acropodite extends through the concavity of the proximal flange. The margins of these flanges, particularly the proximal one, are highly irregular and sometimes jagged, with minute serrations, larger teeth, and in some individuals, a secondary proximal flange, also marginally irregular, arising from the basal lamella; the distal flange is further ornamented by a strong, distally directed spine from the caudal margin. The distal 1/3 of the prefemoral process expands to a subacuminate tip on the inner distal corner, but its principal characteristic is a dense pilosity that arises from the inner and apical margins and nearly obliterates the tip. There are two kinds of hairs—long, relatively straight ones arising marginally and submarginally, and short, curved ones that arise from an overhanging ledge on both the medial and lateral sides and extend at most only to the level of the first hairs. These distal hairs, apomorphic for *Semionellus*, are unique not only in the Chonaphini but also in the family Xystodemidae. I know of no other xystodesmid genus with hairs on either the prefemoral process or acropodite.

The other type of prefemoral process is the narrow projection, which is blade-like, at least basally, in *Montaphe elrodi* and *Metaxycheir*, and subacicular in *Tubaphe*. It curves generally bisinuately, lacks secondary structures in *Metaxycheir* (Figs. 52–53), and subtends a variable arc and possesses modifications in *Montaphe* and *Tubaphe* (Figs. 35–38, 47–48). The projection curves gently and displays minute apical barbules from the inner margin in *Tubaphe* (Figs. 47–48), the latter being shared with *Montaphe elrodi*, in which the barbs are strongly pronounced and extend proximad on the stem of the projection, though still clustered apically (Figs. 35–38). In *M. elrodi* the prefemoral process bends or curves dorsad near midlength, extending well beyond the acropodal curvature, excepting individuals in which the latter is distended (Fig. 38), and tapering smoothly and continuously to a subacuminate tip. The barbs are located distad, and proximal to the bend

is a large, variably cupulate projection from the medial surface with a variably serrate to strongly toothed and jagged distal margin. This structure further varies from a simple curved lamella, with a variably irregular distal margin, to one with two or three marginal lobes or folds, also with variably irregular distal margins.

Acropodite—Except for *Montaphe paraphoena*, chonaphine acropodites vary from narrowly blade-like to acicular, and though devoid of secondary structures, hold taxonomic utility in the general form of their curvatures and in their positions relative to the prefemoral process. Disposing first of *M. paraphoena*, its acropodite expands basally into a thickened, flange-like overhang on the outer medial surface and a strong lateral spine, which is positioned opposite the terminal expansion of the prefemoral process and is obscured by the latter in medial view (Figs. 42–43). Distally, the acropodite narrows somewhat and curls in a broad, open loop that encompasses the entire prefemoral process. By contrast in *M. elrodi*, the acropodite is typical for the tribe, being narrow basally and becoming still narrower and subacicular distad. It usually curls over the prefemoral process at the level of the latter's bend, but occasionally it is distended and lies subparallel to the prefemoral process (Figs. 35–38).

In both *Metaxycheir* and *Tubaphe*, the acropodite curves in the form of a broad, open loop, through essentially a single vertical plane in the latter and through more than one plane in the former. The structure is broader and blade-like in *Metaxycheir*, and its loop extends beyond the distalmost point of the prefemoral process (Figs. 52–53). In *Tubaphe* the acropodite is narrower, becoming acicular distad, and the prefemoral process extends either through the loop or below it (Figs. 47–48).

Chonaphe and *Semionellus* are the only two genera with truly acicular acropodites. In *Chonaphe* it curls around the prefemoral process, inserts onto the shelf, being obscured by the shield, and curves distad along the projection's medial face (Figs. 4–7, 10–13, 22–25). Occasionally the acropodite is displaced and curls above the shelf, thus being clearly visible for its entire length (Figs. 16–19). In *Semionellus* the structure bends strongly basally, is sublinear for most of its length, and curves broadly distad (Figs. 30–31). It typically lies below, and runs generally parallel to, the prefemoral process, but in a few males, it passes through the curvature of the proximal flange. In *Chonaphe*, the acropodite is somewhat coiled and passes through numerous vertical planes, whereas in *Semionellus*, the structure is nearly uniplanar.

Cyphopods—The female genitalia are positioned transversely in the cyphopodal aperture, which encircles the 2nd legs on segment 3;

the caudal margin of the aperture is strongly elevated above the metazonal surface and rises to a peak in the midline. The common valvular surface is visible *in situ*; the receptacle lies beneath the medial corners of the valves; and the operculum is closely appressed to their lateral surfaces. All these structures are hirsute, the receptacles having long hairs arising from the ventral margins and extending beyond the ventral margins of the valves. As the receptacles in other eastern tribes are glabrous, without even a trace of hairs, the hirsute ones enable females of *S. placidus* to be distinguished from sympatric females of other genera. In most chonaphines, the medial valvular margins project distinctly ventrad, thereby creating a central depression or cavity on the common, ventral surface (Figs. 8, 14, 20, 39, 49). *Semionellus* is an exception in that the ventral surface is flat, without a trace of a cavity or prolongation (Fig. 32), as is *C. schizoterminalis*, which has central valvular lobes (Fig. 26). In keeping with its structurally different gonopods, the cyphopods of *Selenocheir* have only slight suggestions of medial lobes and central impressions (Figs. 58, 63, 67). Likewise, the receptacle is alate in most species, being cupped below the medial corners of the valves, narrowing distinctly in the midline, and extending for varying lengths along the anterior and posterior sides of the valves. For the most part, the operculum is relatively large, a distinct sclerite lateral to the valves, instead of an indistinct structure as in most xystodesmids.

Tribe Chonaphini Verhoeff

Chonaphinae Verhoeff, 1941:403.
Chonaphini: Hoffman, 1979:157. Shelley, 1990:2313–2315.

Components—*Chonaphe* Cook, 1904; *Semionellus* Chamberlin, 1920; *Montaphe* Chamberlin, 1949; *Tubaphe* Causey, 1954*a*; *Metaxycheir* Buckett and Gardner, 1969; *Selenocheir*, new genus.

Diagnosis—A tribe of moderate-size Xystodesminae with the following characteristics: gonopodal aperture with caudal margin elevated, ovoid or extending caudad to varying degrees between 9th legs, sternum between latter present as "shelf" in caudal extension; gonocoxae joined by membrane, with or without sclerotized sternal band, latter usually with lobes subtending coxae, occasionally with medial lobe; telopodal elements parallel or not parallel; prefemoral process variable, often elaborately ornamented, short and less than half as long as acropodite or as long or longer than latter, ranging from acicular to narrowly blade-like to expanded and laminate, usually with projections arising from stem or with shallow or deep apical

cleft; acropodite usually simple and unmodified, acicular to narrowly blade-like, either circumscribing variably broad arc, with or without abrupt distal curvature change, bending anteriad at right angle proximally and curving broadly distad, or looping around prefemoral process and inserting on shelf on latter; cyphopods oriented transversely in aperture, with or without prolongations of medial valvular corners and variable central cavities, receptacles alate or flattened, hirsute with variable numbers of long hairs arising primarily from ventral margins.

Distribution—Occurring in parts of western North America and the eastern United States east of the Central Plains from southeastern Minnesota to the Blue Ridge Province of northern Virginia. Mapping the available museum records reveals that the range is divided into 7 separate areas (Fig. 1): along the Pacific Coast in the southwestern corner of Vancouver Island, British Columbia; from the Olympic Peninsula of Washington to the northern coast of California and the central Sierra Nevada Mountains, extending eastward across the Cascade Mountains in Washington to the western fringe of the Columbia Plateau Physiographic Province; from northcentral Oregon and eastern Washington to western Montana and Idaho north of the Salmon River, probably extending just across the International Border into southern British Columbia between Rossland and Creston; from southeastern Minnesota to southeastern Wisconsin; from the central lower peninsula of Michigan through western Ohio to western Indiana; a single site in southeastern Ohio near the Ohio River; and from western Maryland through eastern West Virginia to the Blue Ridge Province of westcentral Virginia, terminating in Shenandoah National Park.

Remarks—The anatomical diversity in this diplopod assemblage presents formidable obstacles to formulating a tribal diagnosis, as several key features have exceptions. The gonopodal apertures are large and expanded caudad in all chonaphines except *C. evexa*, *T. levii*, and *Selenocheir sinuata*; *T. levii* and the species of *Selenocheir* are the only representatives lacking a sternal remnant; *Montaphe paraphoena* is the only chonaphine lacking an acicular to narrowly blade-like acropodite and the only one with the gonosternum lacking lateral lobes; the species of *Selenocheir* are the only ones with short prefemoral processes; and *Metaxycheir prolata* is the only component with a long prefemoral process that lacks modifications. To my knowledge the Chonaphini is the only xystodesmid tribe in which the presence or absence of a sternum is not constant, but the narrow aperture of *Tubaphe* is shared with *C. evexa* and *S. sinuata*; the caudally extended apertures of *S. arcuata* and *S. directa* are shared with other chonaphines; and the barbules on the prefemoral process of *T. levii* are shared with

Montaphe elrodi. After evaluating all the specimens cited herein, it is apparent that all these genera are related and comprise a distinct faunal assemblage despite the absence of a unifying anatomical feature. The closest such trait is the narrowly blade-like to acicular acropodite, the only exception being *Montaphe paraphoena*.

The previous range description (Shelley 1990) was published before field expeditions to Washington, Idaho, and Montana. The specimens collected on these trips plus additional museum samples reveal that the distribution in the western United States is not contiguous and that a separate "finger" extends southward along the Blue Mountains into Oregon from eastern Washington. Foremost among the new specimens are the syntypes of *P. armatus* at the PMNH (Shelley 1993*b*), and three additional samples from Grant and Umatilla counties, Oregon (WAS), which confirm the species in this range. An additional record of *S. placidus* from eastern Ohio, shown as a solitary spot in figures 1 and 69, suggests that the central and eastern areas of this species may eventually be connected.

Key to Genera of the Chonaphini, based primarily on adult males.

1. Prefemoral process short, less than half as long as acropodite (Figs. 54–55, 60–61, 65–66); Jackson and Curry counties, Oregon, to Mendocino and El Dorado counties, California .... *Selenocheir*, new genus

   Prefemoral process longer, nearly as long as to longer than acropodite 2

2. Prefemoral process generally long and slender, acicular or blade-like, expanding only distad if at all, with or without variable processes 3

   Prefemoral process broadly expanded and laminate throughout length 5

3. Prefemoral process blade-like and unadorned, without projections, (Figs. 52–53); Latah and Benewah counties, Idaho .... *Metaxycheir* Buckett and Gardner

   Prefemoral process either with variably long barbules or distally expanded 4

4. Paranota variably broad and distinct throughout body; gonosternum present (Figs. 34, 41); Douglas County, Washington, to Lake County, Montana ..... *Montaphe* Chamberlin

   Paranota present on segments 1-5 only, remaining segments appearing nearly julidan, with at most only ozopore swellings (Fig. 45); gonosternum absent, coxae connected by membrane only; Vancouver Island, British Columbia, to

Jefferson County, Washington ..... *Tubaphe* Causey

5. Prefemoral process upright, without distal hairs; distal part of acropodite inserting onto narrow shielded ledge on prefemoral process (Fig. 47); King and Chelan counties, Washington, to Grant and Coos counties, Oregon, and Missoula County, Montana ..... *Chonaphe* Cook

Prefemoral process bent abruptly dorsad at 1/3 length, with dense distal hairs on inner and apical margins, without ledge; acropodite usually lying parallel to prefemoral process (Figs. 30–31); southeastern Minnesota to westcentral Virginia ..... *Semionellus* Chamberlin

Genus *Chonaphe* Cook

Chonaphe Cook, 1904:56. Attems, 1931:65; 1938:155–156. Chamberlin and Hoffman, 1958:27. Jeekel, 1971:253. Hoffman, 1979:157. Kevan, 1983:2968.

Type species—Polydesmus armatus Harger, 1872, by original designation.

Diagnosis—Paranota present and variably distinct on all segments; epiproct without constriction; gonocoxae widely segregated by narrow sternal band, latter with lateral lobes; telopodal elements not parallel, arising proximad on prefemur; prefemoral process long, expanded and laminate, elaborately ornamented, with shielded ledge or shelf near midlength on dorsal surface; acropodite acicular, passing through numerous vertical planes, looping around prefemoral process and curling onto shelf; cyphopod valves with medial corners usually prolonged ventrad, subtending central cavity.

Description—A genus of moderately large to large chonaphine Xystodesminae with the following characteristics:

Body composed of head and 20 segments in both sexes, essentially parallel sided, tapering at both ends.

Head of normal appearance, smooth, polished. Epicranial suture faint or distinct, terminating above interantennal region. Antennae relatively short and broad, becoming progressively more hirsute distad, with 4 conical sensory cones on ultimate article, no other sensory structures apparent. Genae not margined laterally, with faint or distinct central impressions, ends narrowly rounded and extending just beyond adjacent cranial margins. Facial setae with epicranial, interantennal, frontal, genal, clypeal, and labral series present, with or without supraantennal and subantennal series.

Terga smooth, polished. Collum relatively broad, ends terminating above or at same level as those of following tergite. Paranota moderate-size to well developed, broadest on segments 1-5/6, moderately declined, angling ventrolaterad and interrupting or continuing slope of dorsum, anterior corners rounded throughout or blunt on segments 2–3, caudolateral corners variable, either blunt or with suggestion of tooth on anteriormost segments and round on remaining tergites, or squared on anteriormost segments, becoming blunt in midbody region and blunt caudal to midlength. Peritremata broad, distinct to moderately distinct, moderately to strongly elevated above paranotal surface; ozopores located caudal to midlength, opening laterad to sublaterad. Caudal segments normal for family.

Sides of metazonites variable, with or without variable grooves, impressions, or ridges above pregonopodal coxae. Strictures distinct. Gonapophyses moderately long and stout. Pregonopodal sterna glabrous; 4th unmodified or with variable lobes, medially coalesced or widely segregated; 5th sternum with flattened ridges or low, widely segregated projections between anterior (4th) legs and depression between 5th legs; 6th sternum with strong depression between both legs to accommodate stems of telopodites, 7th legs set slightly farther apart than 6th. Postgonopodal sterna glabrous, with broad, shallow, central impressions but otherwise without modifications, caudal margins smooth, gently curved. Coxae without projections; prefemora either without ventrodistal spines or with variably short spines on legs in caudal half of body; tarsal claws gently curved. Hypoproct broadly rounded, paraprocts with margins strongly thickened.

Gonopodal aperture generally ovoid, either extending caudad between 9th legs or terminating anterior to latter, with or without slight anteriolateral indentations, anterior margin and anterior halves of sides flush with metazonal surface, latter elevating caudad and continuing onto caudal margin, either descending in midline or continuing at level elevation. Gonopods *in situ* with telopodites extending anteriad from aperture and lying parallel to each other, overhanging 6th and caudal half of 5th sterna. Coxae variable in size, either with 2, or linear field of 4–8, macrosetae, well separated from each other by narrow sternal band, latter with short to moderate lobes subtending coxae. Telopodal elements not parallel, arising proximad on prefemur; latter moderately long and slender; prefemoral process large, arising from anteromedial or anterior margins, narrow basally, expanding greatly at 1/3 to 1/4 length into ledge or shelf on dorsal side, outer margin extending beyond latter to form translucent shield, stem of prefemoral process continuing distad with variably irregular margins, either with

thickened irregular, convoluted projection on dorsal side at 3/4 length or with angular ridge or flange, stem either broadly rounded apically and with inturned lateral subapical lobe, or deeply divided with narrow lateral and broad medial terminations of subequal length, or with suggestion of division and with lateral side either bent strongly dorsad and transversely to stem, or not bent and with laminate, coaxial projection on dorsal side, or expanding distad and leaning over stem. Acropodite acicular, arising on caudal or caudolateral sides of prefemur, looping around prefemoral process and curling onto shelf, apically acuminate. Prostatic groove arising in pit in prefemur, extending along medial face of latter onto acropodite, running generally along inner surface of loop to apical opening.

Cyphopodal aperture broad, encircling 2nd legs, sides and caudal margin elevated above metazonal surface. Cyphopods *in situ* with valves oriented transversely, common surface visible in aperture. Valves variable in size, subequal, lightly to moderately hirsute, medial corners extending ventrad into variable lobes, subtending central depressions. Receptacle small to moderately large, hirsute, or with variable numbers of hairs arising from ventral margins, either cupped around valves or flat and inconspicuous. Operculum relatively large, located laterad to valves, with numerous long hairs.

Distribution—Occurring in five segregated areas in the northwestern United States as follows: Coos County, Oregon; Grant and Umatilla counties, Oregon; Benton County, Oregon, to Mason and Chelan counties, Washington; and Stevens and Whitman counties, Washington, to Missoula County, Montana. This total area covers about 468 mi (753 km) in the east-west dimension and 351 mi (565 km) in the north-south, and encompasses parts of the Northern Rocky Mountains, Columbia Plateau, Sierra Cascade, and Pacific Border Physiographic Provinces.

Species—Four are known; more may occur in isolated pockets within the generic range.

Key to Species of *Chonaphe* (based on adult males)

1. Prefemoral process with broad, thickened, convoluted projection from dorsal surface distal to shelf (Figs. 5–6, 11–12) 2
   Prefemoral process with angular ridge or expanded flap on dorsal surface distal to shelf (Figs. 16, 18, 22–23) 3
2. Apical margin of prefemoral process with lateral side acuminate, bent abruptly dorsad, lying transverse to axis (Figs. 4–6); Stevens and Chelan to Yakima counties, Washington; Multnomah to Benton and Umatilla to Grant counties, Oregon; and Sanders County, Montana, to Kootenai and Idaho

counties, Idaho ..... *armata* (Harger)

Distal extremity of prefemoral process with coaxial, marginally serrate projection on dorsal surface (Figs. 10–12); King and Mason to Skamania counties, Washington ..... *remissa* Chamberlin

3. Apical margin of prefemoral process broadly rounded, entire, distolateral margin inturned dorsad, forming short subterminal lobe; ridge on anterior surface only slightly elevated above stem of projection, not laminate (Figs. 16–19); Coos County, Oregon ..... *evexa*, new species

Apical margin of prefemoral process gently curved, deeply divided, lateral side forming long, slender dactyliform projection, subequal in length to broader medial projection; ridge on anterior surface elevated and expanded into laminate flange or flap, overlaying shield (Figs. 22–25); Stevens County, Washington ..... *schizoterminalis*, new species

Chonaphe armata (Harger)

Figs. 2–8

Polydesmus armatus Harger, 1872:119–120. pl. II, fig. 8.

Leptodesmus armatus: Bollman, 1893:122. Chamberlin, 1911:264.

Chonaphe armata: Cook, 1904:56–57, pl. III, figs. 2a-c. Attems, 1938 (in part):156, fig. 177. Chamberlin, 1949:125. Chamberlin and Hoffman, 1958:27. Kevan, 1983:2968. Shelley, 1990:2314; 1993*b*:9–10, figs. 4-5.

Chonaphe cygneia Chamberlin, 1949:125, fig. 1. Chamberlin and Hoffman, 1958:27. Kevan, 1983:2968. NEW SYNONYMY.

Chonaphe patriotica Chamberlin, 1949:127, figs. 2–3. Chamberlin and Hoffman, 1958, 1958:27. Kevan, 1983:2968. NEW SYNONYMY.

Chonaphe serratus Loomis and Schmitt, 1971:111–112, figs. 1-2. NEW SYNONYMY.

Chonaphe serrata: Kevan, 1983:2968.

Type specimens—One male and two female syntypes (PMNH) collected by O. Harger and G. H. Collier in October 1871 from the vicinity of Canyon City, Grant County, Oregon.

Diagnosis—Dorsal surface of prefemoral process with broad, thickened, irregular projection distal to shelf; apical margin sublinear to gently indented, lateral half curving anteriad and lying transversely to axis, apically acuminate; shield not connecting with lateral margin.

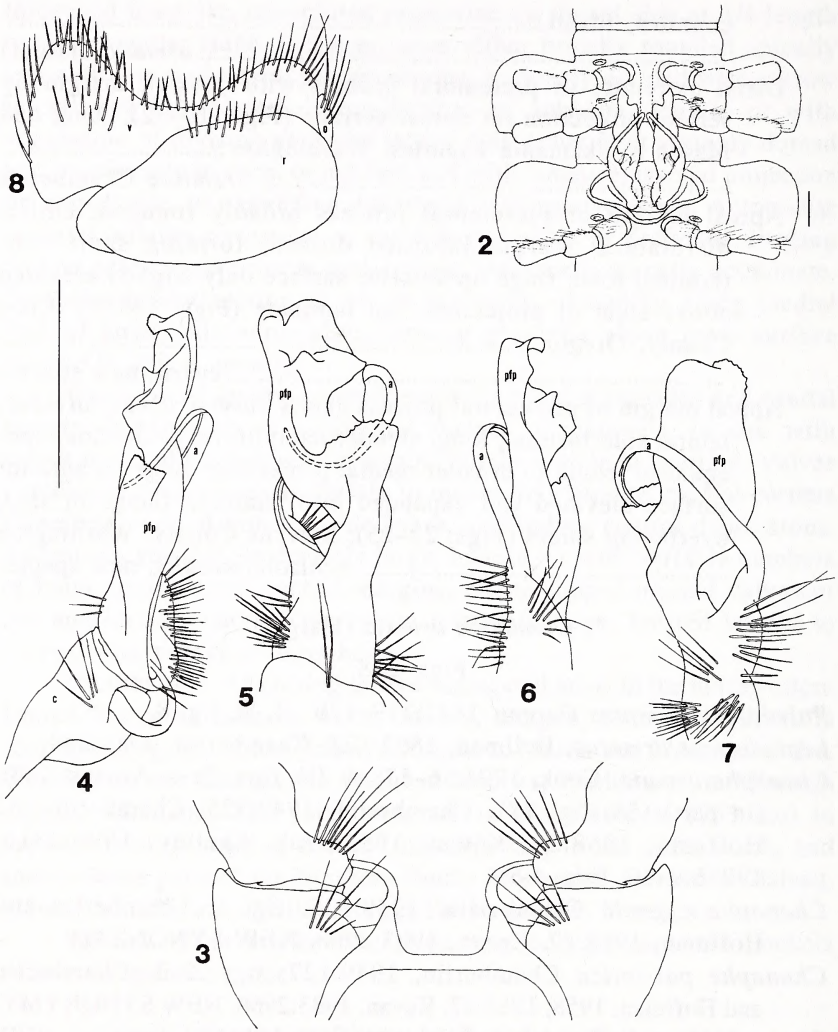


Fig. 2-8. *Chonaphe armata*. 2, gonopods *in situ*, ventral view of male from Latah County, Idaho. 3, gonocoxae and sternum, dorsal view of specimen from Chelan County, Washington. 4, left gonopod of male from Umatilla County, Oregon, medial view. 5, telopodite of the same, dorsal view. 6, the same, lateral view. 7, the same, ventral view. 8, left cyphopod of female from Latah County, Idaho, caudal view. a, acropodite; c, coxa; o, operculum; pfp, prefemoral process; r, receptacle; v, caudal valve. Scale line for Figure 2 = 1.00 mm; line for other Figures = 2.78 mm for 3, 2.00 mm for 4-7, 1.00 mm for 8.

Color in life—Metaterga black, without spots and usually without stripes, paranota white, cream-colored, yellow, or light reddish orange; collum without a stripe along anterior margin.

Male syntype—Length 23.3 mm, maximum width 4.3 mm, W/L ratio 18.5%, D/W ratio 65.1%. Body parallel sided for most of length, tapering at both ends.

Head capsule smooth, polished; epicranial suture shallow, indistinct, terminating above interantennal region. Width across genal apices 2.3 mm, interantennal isthmus 0.8 mm. Antennae appearing relatively short and broad, reaching back to caudal margin of 3rd tergite; relative lengths of antennomeres 2>3>6>4=5>1>7. Genae with moderately distinct central impressions, ends broadly rounded and extending slightly beyond adjacent cranial margins. Facial setae as follows: epicranial 1-1, interantennal absent, frontal 1-1, genal 3-3, clypeal about 8-8, labral about 12-12.

Collum broad, ends terminating at same level as those of adjacent tergite. Paranota well developed throughout body, broadest on segments 1-6, angling ventrolaterad but interrupting slope of dorsum, anterior corners rounded, caudolateral corners squared on segments 2–5, slightly acuminate on 6–8 and 11, blunt on 9–10 and 12–13, angling caudad on 14–17. Peritremata distinct, strongly elevated above paranotal surface; ozopores located caudal to midlength, opening sublaterad.

Sides of metazonites generally smooth, polished, with variable curved, shallow impressions. Pregonopodal sterna glabrous; 4th sternum unmodified; 5th sternum with two low, rounded, widely separated elevations between anterior (4th) legs and concave depression between 5th legs to accommodate apices of telopodites. Prefemora of legs on segments 11–18 with short but distinct, ventrodistal spines.

Gonopodal aperture extending caudad between 9th legs, 1.8-mm wide and 1.0-mm long at midpoint, without indentations, sides elevating into broadly rounded, caudolateral lobes, lower in midline. Gonopods *in situ* (Fig. 2, not this specimen) with telopodites situated in opposite sides of aperture, well separated from each other, extending anteriad in parallel arrangement over coxae of legs 6–7 (on segment 6), terminating over 5th legs and sternum of segment 5. Gonopod structure as follows (Figs. 3–7): Coxae of normal size and appearance, with linear fields of 4–6 macrosetae, well segregated by broad sternum, latter with moderate-size lateral lobes. Prefemur moderately long, with large prefemoral process arising from anteromedial surface, latter narrow basally and leaning slightly laterad, expanding at 1/3 length into ledge or shelf on dorsal side, outer margin extending beyond surface of ledge as translucent shield, stem of prefemoral process continuing distad

with irregular to lightly serrate edges, expanding again at 3/4 length into broad, thickened irregularly convoluted projection on dorsal side, distal extremity of stem thin and lamellate, apical margin gently concave, lateral side bent strongly dorsad, lying transversely to axis, apically acuminate, medial side not bent, apically rounded. Acropodite arising on caudolateral side of prefemur, angling anteromediad over ventral surface of prefemoral process, looping around medial surface of latter, and curling onto shelf, obscured by shield, curving distad along dorsal face of process to acuminate tip.

Female syntype—Body highly fragmented, length unmeasurable, maximum width 4.2 mm, D/W ratio 75.6%. Agreeing essentially with males in structural details except paranota more declined, giving appearance of slightly more vaulted body. Valves (Fig. 8) relatively large, moderately hirsute, with large medial lobes protruding through midline of aperture, subtending deep central depression. Receptacle large, lightly hirsute along ventral margin, cupped around valves, extending slightly more on caudal side than on anterior.

Variation—There is considerable variation in color. The pattern is generally bimaculate with colored paranota and uniformly black metaterga, but two males that I collected at Elk Creek Falls Recreation Area, Clearwater County, Idaho, displayed broad yellow bands, concolorous with the paranotal markings, along the caudal margins of tergites 12–17. The paranotal spots vary in color being white to cream-colored on specimens that I encountered in Multnomah County, Oregon, reddish-orange on ones from Stevens County, Washington, and bright lemon yellow on ones from Latah and Clearwater counties, Idaho.

On the gonopods, the size and degree of irregularity of the distal projection from the dorsal face of the prefemoral process varies considerably. In some males, the structure is much larger and more flattened than shown in figures 4–7, becoming a second, more distal, and unprotected shelf; in others, it is more irregular and convoluted, and occasionally the side margins curl upwards, forming lips and demarcating a narrow, elongate trough or groove. In still others, the tip of the projection bends or curves laterad. The apical gonopodal margin is as shown in figures 4–7 in all specimens except those from Stevens County, Washington, in which the entire margin, not just the lateral side, is bent dorsad. As there is only one sample with this configuration, I include it under *C. armata*, but future workers with access to more material may conclude that this condition is significant enough to warrant specific recognition.

In females, the size of the medial projection of the valves varies, some being very large and overshadowing the rest of the valves. The

receptacle in some females is larger than that of the syntype, extending ventrad along the lateral surface of the valves and partly enclosing the operculum as well as being cupped around the anterior and caudal surfaces. These receptacles are saddle or bowl-shaped, with the valves situated on top in a ventral depression.

Ecology—The specimens that I collected in Multnomah County, Oregon, were wandering over the substrate in deciduous forests; those from Stevens County, Washington, were under partly buried, "stuck," pine and fir logs and detached pieces of bark beside a dirt driveway in a predominantly pine woods; and those from Latah and Clearwater counties, Idaho, on and under logs, moss, and leaves. Specimens from Chelan County, Washington, were also found "active on ground." Labels with preserved samples indicate that *C. armata* has been encountered in willow litter, under rocks and fungi, under logs near streams, under rotten logs, on moist hillsides, and under cow dung.

Distribution—Occurring in five segregated areas in the northwestern United States: the lower Willamette Valley of Oregon, the eastern slope of the Cascade Mountains in central Washington, the western slope of the Blue Mountains, northern Idaho and western Montana, and an isolated site in Stevens County, Washington (Figs. 68, 70). Specimens were examined as follows:

OREGON: *Benton Co.*, ca. 16 mi (25.6 km) N Corvallis, Finley Natl. Wildlife Ref., 7M, F, 31 March 1972, L. Russell (VMNH) and 2M, F, 26-28 April 1978, D. R. Breakey (WU). *Polk Co.*, Zena, 4-H Camp, M, 23 April 1983, D. R. Breakey (WU). *Marion Co.*, 2.5 mi (4.0 km) W Mehama, 4M, 2F, 30 March 1969, R. L. Westcott (UCD). *Clackamas Co.*, West Linn, MM, FF, 6 May 1972, L. Russell (VMNH). *Multnomah Co.*, Portland, 2M, 19 June 1882, L. Henshaw (MCZ); South Portland, M, May 1905, J. E. Benedict (NMNH); and Columbia River Gorge, Oneonta Trail between Horsetail Falls and Oneonta Gorge, M, 2 June 1991, R. M. Shelley (NCSM) and John B. Yeon St. Pk., along trail to Elowah Falls, 4M, 3 June 1991, R. M. Shelley (NCSM). *Umatilla Co.*, jct. N and S Forks, Umatilla R., M, 6 July 1967, F. A. Coyle (WAS); 3.0 mi (4.8 km) NE Gibbon, along Umatilla R., M, 7 July 1967, F. A. Coyle (WAS); 10.0 mi (16.0 km) E Ukiah, Bear Wallow Cpgd. along OR hwy. 244, M, 7 July 1967, F. A. Coyle (WAS). *Grant Co.*, vic. of Canyon City, M, 2F, October 1871, O. Harger, G. H. Collier (PMNH) TYPE LOCALITY.

WASHINGTON: *Stevens Co.*, along Springdale to Hunters Rd., 13.5 mi (21.6 km) W jct. WA hwy 231, 6M, 4F, 1 June 1993, R. M. Shelley (NCSM). *Chelan Co.*, Soda Spring, ca. 7.9 mi (12.6 km) W

Telma, 47.858°N, 120.968°W, M, 20-22 June 1974, R. Crawford (UWBM); Wenatchee Ridge, ca 7.2 mi (11.5 km) W Telma, 47.860°N, 120.959°W, M, F, 20 June 1974, R. Crawford (UWBM); along Roaring Creek, ca 6.5 mi (10.4 km) W Entiat, 47.687°N, 120.335°W, M, 15 June 1985, R. Crawford (UWBM); along Entiat Summit Road, ca 7.9 mi (12.6 km) N Cashmere, 47.638°N, 120.440°W, 2M, 2F, 12 June 1982, R. Crawford (UWBM); along US hwy. 2 ca 11.9 mi (19 km) N Leavenworth, 4M, 24 April 1988, C. S. Guppy (RBCM); and along US hwy. 2, ca 10 mi (16 km) N Leavenworth, Tumwater Cpgd., 6M, 4F, 18 August 1990 R. M. Shelley (NCSM). *Kittitas Co.*, Cle Elum, 47.15°N–25°N, 120.90°W, M, 9 May 1953, J. J. Gevers (UWBM); Thorp, 47.0°N, 120.6°W, M, 22 May 1954, Kilpatrick (UWBM); 5 mi (8 km) W Ellensburg, F, 4 June 1940, E. F. Dailey (UWBM); beside Yakima R. opposite Ellensburg, 3M, 8 July 1882, S. Henshaw (MCZ); and mouth of Moonlight Cyn., ca. 7 mi (11.2 km) W, 3.4 mi (5.4 km) N Thorp, 47.119°N, 120.822°W, M, 25 May 1986, R. Crawford (UWBM). *Yakima Co.*, Taylors, Wenas Valley, M, 6 July 1882, S. Henshaw (MCZ); and White Swan, M, 7 May 1938, W. W. Baker (NMNH).

IDAHO: *Kootenai Co.*, locality unspecified, M, September 1890, Leiberg (NMNH); 4th of July Cyn., M, 12 August 1929, R. V. Chamberlin (NMNH); and Medimont, 3M, F, 23 June 1957, H. S. Dybas (FMNH). *Benewah Co.*, 4 mi (6.4 km) SE Emida, M, 3F, 16 April 1987, R. S. Zack (WSU). *Shoshone Co.*, mouth of Eighty Day Cr., 1.3 mi (2.1 km) up Steamboat Cr. from mouth at Coeur d'Alene R., M, 23 May 1975, F. W. Grimm (CMN); and 8 mi (12.8 km) ENE Clarkia, Hobo Cedar Grove, 4M, 12 June 1985, W. Suter (UWY). *Latah Co.*, Laird Park, 8 mi (12.8 km) NE Harvard, Idaho Panhandle Nat. For., M, 9 June 1982, R. S. Zack (WSU) and 3M, F, 4 June 1993, R. M. Shelley (NCSM); 4.5 mi (7.2 km) N, 8.5 mi (13.6 km) E Harvard, Cleveland Gulch, M, F, 16 September 1978, A. K. Johnson (NCSM); 3 mi (4.8 km) N, 6.5 mi (10.4 km) E Harvard, along Blue Jacket Cr., M, 15 September 1978, A. K. Johnson (NCSM); nr. Harvard, Idaho Panhandle Nat. For., 2M, 22 July 1934, B. Malkin (CAS, WSU); E of Bovill, along Bob's Cr., F, 30 May 1985, C. Rogers (WSU); and 6 mi (9.6 km) E Bevrit, along Roger's Cr., 4M, F, 20 May 1986, along Roger's Cr., 4M, F, 20 May 1986, R. S. Zack (WSU). *Clearwater Co.*, Elk Cr. Falls Rec. Area E of Bovill, 2F, 8 August 1991, and 4M, 2F, 4 June 1993, R. M. Shelley (NCSM); 3.5 mi (5.6 km) N, 6.4 km (4.0 mi) E Headquarters, along Middleton Cr., 13M, 13 August 1978, A. K. Johnson (NCSM); 3.5 mi (5.6 km) N, 7.0 mi (11.2 km) W Pierce, 8M, 2F, 25 June 1978, A. K. Johnson (NCSM); and Greer, 2F, 30 August 1959, W. J. Gertsch, V. Roth (NMNH). *Idaho Co.*, 6.0 mi

(9.6 km) E, 9.0 mi (14.4 km) S Pierce, 0.5 mi (0.8 km) N Austin Ridge Lookout, 4M,2F, 30 June 1978, and 15M, 2F, 29 July 1978, A. K. Johnson (NCSM); 10.5 mi (16.8 km) E, 6.0 mi (9.6 km) S Pierce, Knoll Cr. Cyn., 2M, 3F, 25 August 1978, A. K. Johnson (NCSM); 13.0 mi (20.8 km) SSE Pierce, Eldorado Ridge, 2M, 18 July 1978, and 2M, 3F, 25 August 1978, A. K. Johnson (NCSM); 3.0 mi (4.8 km) W Lowell, M, 18 July 1963, W. F. Barr (FSCA); and Lowell, M, F, 4 July 1949, C. O. Bowles (NMNH).

MONTANA: *Sanders Co.*, 1.0 mi (1.6 km) W Noxon, 2M, F, date unknown, R. Schmitt (NMNH, FSCA); Thompson Falls, 5M, F, 16 August 1967, J. R. Helfer (UCD); and 3.0 mi (4.8 km) SSE Thompson Falls, Clark's Peak, Lolo Nat. For., 5M, 4 July 1950, B. Malkin (CAS, NMNH, WSU). *Missoula Co.*, Missoula, M, 7 July 1950, B. Malkin (NMNH).

The following literature record is considered accurate and indicated by the open symbol in figure 68.

WASHINGTON: *Whitman Co.*, Madson (misspelled as Madison), ca. 3 mi (4.8 km) W, 1 mi (1.6 km) S of Viola, Latah Co., ID (Chamberlin 1911).

Remarks—Hoffman (1979) suggested that the then five nominal species of *Chonaphe*—*armata*, *cygneia*, *patriotica*, *remissa*, and *serratus*—might be subspecifically related, and I (Shelley 1990) suggested that the genus might be monotypic with all these names synonyms of *armata*. However, the unpublished record that I cited from King County, Washington, is referrable to *C. remissa*, and the one from Stevens County, Washington, is a misidentification of a new species, *C. schizoterminalis*.

The newly cited records from Umatilla County, Oregon, are in the Blue Mountains of eastern Oregon and corroborate my conclusion (Shelley 1993*b*) that the type locality is in this range. In May 1993 I spent two days in the vicinity of Canyon City, Grant County, the presumptive type locality, attempting without success to confirm the occurrence of *C. armata* in the southern Blue Mountains. This area has been drastically altered by lumbering, and the only remaining hardwoods are narrow willow and alder thickets along creeks. The predominant vegetation is pine, and most of the southern Blue Mountains are unsuitable for xystodesmids, which occur primarily in hardwood associations. When Harger collected the types in October 1871, there was surely an extensive hardwood community in the broad John Day River Valley near the present towns of Mt. Vernon, John Day, and

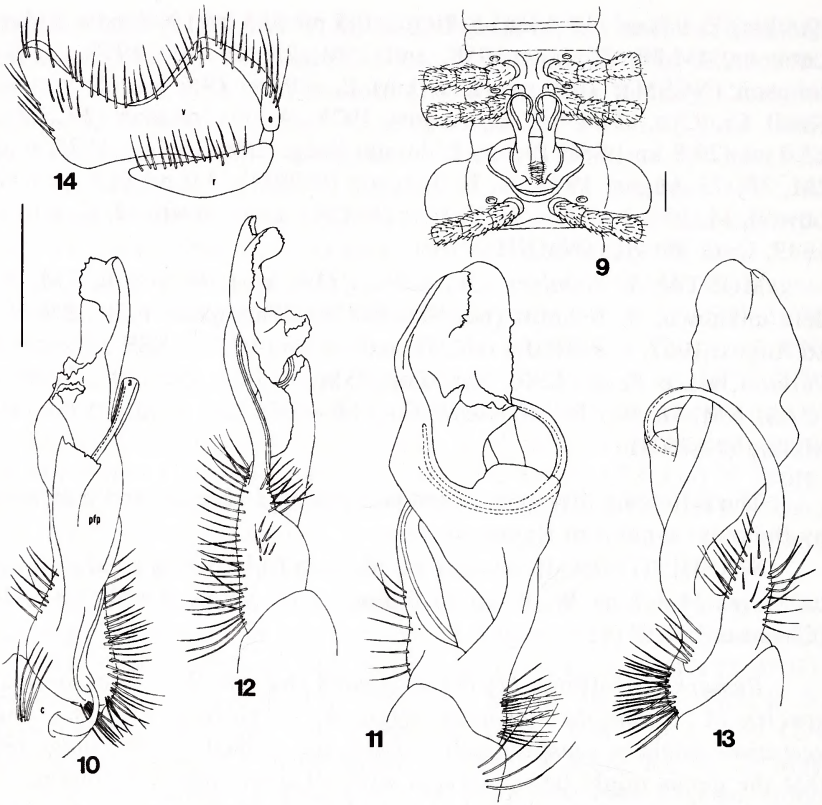


Fig. 9-14. *Chonaphe remissa*. 9, gonopods *in situ*, ventral view of male from King County, Washington. 10, left gonopod of holotype, medial view. 11, telopodite of the same dorsal view. 12, the same, lateral view. 13, the same, ventral view. 14, left cyphopod of female from Skamania County, Washington, caudal view. Abbreviations as in Figs. 2-8. Scale line for Fig. 9 = 1.00 mm; line for other Figs. = 1.30 mm for 10-13, 1.00 mm for 14.

Prairie City, and also along Canyon Creek, a fast-running tributary that flows through Canyon City and enters the main river at John Day. Staying in Canyon City (Shelley 1993*b*), Harger probably did not have to go far to find his new millipeds and centipede, but in May, I drove all the major highways and many back roads in the vicinities of these towns without finding any of the species or even suitable habitat. Consequently, the record of *C. armata* from Grant County in the southern Blue Mountains (Fig. 68) may reflect more of the historical range than present occurrence.

Chonaphe remissa Chamberlin

Figs. 9–14

Chonaphe armata: Attems, 1931:65–67, figs. 100–101; 1938 (in part):156, fig. 177. Verhoeff, 1941:fig. 5.

Chonaphe remissa Chamberlin, 1949:127, figs. 4–5. Chamberlin and Hoffman, 1958:27. Kevan, 1983:2968.

Type specimen—Male holotype (NMNH) collected by W. W. Baker, 2 May 1933, at Puyallup, Pierce County, Washington.

Diagnosis—Dorsal surface of prefemoral process with broad, thickened, irregular projection distal to shelf; apical margin slanting laterad, lateral side with vertical lamina lying along axis, marginally serrate; shield connecting with inturned lateral margin.

Color in life—Unknown, but evidence of light paranotal spots on preserved specimens.

Holotype—Length 24.5 mm, maximum width 5.3 mm, W/L ratio 21.6%, D/W ratio 75.5%.

Somatic features agreeing with those of *C. armata*, with following exceptions:

Epicranial suture distinct, terminating just above interantennal region. Width across genal apices 3.2 mm, interantennal isthmus 1.1 mm. Antennae reaching back to midlength of 4th tergite, relative lengths of antennomeres 2>3>4>5=6>1>7. Genae with distinct central impressions. Facial setae as follows: epicranial 2-2, suprantennal 1-1, interantennal 1-1, subantennal 1-1, frontal 1-1, genal 1-1, clypeal about 11-11, labral about 14-14, merging with clypeal series and continuing for short distance along genal margins, about 3 setae per side.

Sides of metazonites with low, variable ridges above coxae on pregonopodal segments. 4th sternum with moderately large, medially coalesced projections between 3rd legs, length subequal to widths of adjacent coxae; 5th sternum with two shorter, widely separated projections between 4th legs and slight depression between 5th legs. Prefemora of legs on segments 15–18 with distinct distoventral spines, longest on segments 16–17.

Gonopodal aperture extending caudad between 9th legs, 1.8-mm wide and 0.9-mm long at midpoint, without indentations, sides elevating strongly caudad and continuing onto caudal extension. Gonopods *in situ* (Fig. 9, not this specimen) extending anteriad from aperture over segment 6 and the caudal part of segment 5. Gonopod structure as follows (Figs. 10-13): Coxae with linear fields of 5–8 macrosetae; sterna with moderate-size lobes subtending coxae. Prefemoral process arising from anteromedial surface, narrow basally, expanding greatly

at 1/4 length into ledge or shelf on dorsal side, outer margin extending beyond surface of ledge as translucent shield, tapering toward and connecting with inturned lateral margin, stem of prefemoral process continuing distad with lightly serrate margins, with broad, thickened, irregularly convoluted projection from caudal surface, apical margin slanting laterad, with perpendicular, marginally serrate lamina projecting from dorsal surface lateral to midline. Acropodite arising on caudolateral side of prefemur, looping around prefemoral process and curling onto shelf, curling distad and terminating behind lateral extension of shield.

Female from Skamania County, Washington—Body fragmented, length unmeasurable, maximum width 5.9 mm, D/W ratio 71.4%. Agreeing closely with holotype in structural details, except paranota more strongly declined, creating appearance of more vaulted body. Valves (Fig. 14) moderately large, moderately hirsute, medial corners strongly elevated, subtending deep central depression. Receptacle small, situated directly beneath or dorsal to valves on lateral side, hirsute along ventral surface, extending slightly around caudal side of latter but not around anterior side.

Variation—As in *C. armata*, the size and degree of irregularity of the distal projection of the prefemoral process varies, being larger and more convoluted in some males. The sides of the projection occasionally have variable teeth that project above the flattened distal surface, which may be level or slant downward. The shield curves distad and continues for varying distances beyond the shelf, connecting with the inturned lateral margin. In some males, this continuation extends to the distal extremity of the prefemoral process, where it is very narrow and indistinct; in others, the continuation ends near the level of the distal projection, and the inward curving lateral margin distal to this point is separate.

Ecology—The specimen from Mason County was taken from sabal/alder litter at the edge of a marsh; that from Grays Harbor County was found on a canyon wall; and those from Ape Cave, Skamania County, were recovered from a pitfall trap just inside the main entrance.

Distribution—Washington west of the crest of the Cascade Mountains. Specimens were examined as follows:

WASHINGTON: *King Co.*, Seattle, M, 9 April 1936, E. F. Dailey (UWBM); and Snoqualmie Falls, M, 19 May 1933, M. H. Hatch (FSCA). *Pierce Co.*, Puyallup, M, 2 May 1933, W. W. Baker (NMNH) TYPE LOCALITY. *Mason Co.*, Dennie Ahl Seed Orchard, ca. 5 mi (8 km) W Potlach, 47.379°N, 123.257–259°W, M, 6 May 1986, R. Crawford (UWBM). *Grays Harbor Co.*, along Canyon River, ca. 7.0 mi (11.2 km) WNW Matlock, nr. Mason Co. line, 47.262°N, 123.526°W, M, 29

August 1976, J. T. Thompson (UWBM). *Skamania Co.*, Ape Cave, ca. 4.4 mi (7.0 km) E, 4.0 mi (6.4 km) N Cougar (in Cowlitz Co.), 46.109°N, 122.210°W, M, F, 13–30 May 1983, R. Crawford (UWBM).

The following literature record of *C. armata* is referrable to *C. remissa*.

WASHINGTON: *Thurston Co.*, farm near Olympia (Attems 1931); Verhoeff's gonopod illustration (1941, fig. 5) is of this specimen.

Remarks—Most prior records of *C. armata* actually refer to *C. remissa*, as no one realized that the Cascade Mountains in Washington form a distributional boundary, with a different species on each side of the crest. An addition to the above record is the general comment by Loomis and Schmitt (1971) that *C. armata* occurs in the Puget Sound area. However, south of the Columbia River in Oregon, *C. armata* occurs in the Willamette Valley and eastern slope of the Coast Range, and both the genus and tribe are absent from the Cascades.

The prefemoral processes of *C. armata* and *remissa* are very similar and can be confused but the apical lamina is vertical or coaxial with the stem in the latter and horizontal or transverse to it in the former. Additionally, the thickened, convoluted, distal projection is more proximal in C. *remissa*, being closer to the shelf/shield and farther from the tip; in *C. armata*, it is situated closer to the tip, occurring almost in the middle between the shelf and tip. The shield is longer in *C. remissa*, extending well along the lateral side of the stem of the prefemoral process; it terminates at the level of the shelf in *C. armata*.

Chonaphe evexa, new species

Figs. 15–20

Type specimens—Male holotype and 1 male and 1 female paratypes (UCD), and 1 male paratype (NCSM), collected by J. S. Buckett and M. R. Gardner, 11 March 1968, 9 mi (14.4 km) north of Agness, Coos County, Oregon.

Diagnosis—Dorsal surface of prefemoral process without projection distal to shelf, with angular ridge; apical margin broadly rounded, continuing downward to blunt termination on medial side, not divided but with subterminal lateral margin inturned to narrowly rounded, subacuminate tip; shield not connecting with lateral margin.

Color in life—Unknown, but evidence of paranotal spots in preserved specimens.

Holotype—Length 21.5 mm, maximum width 3.4 mm, W/L ratio 15.8%, D/W ratio 82.4%.

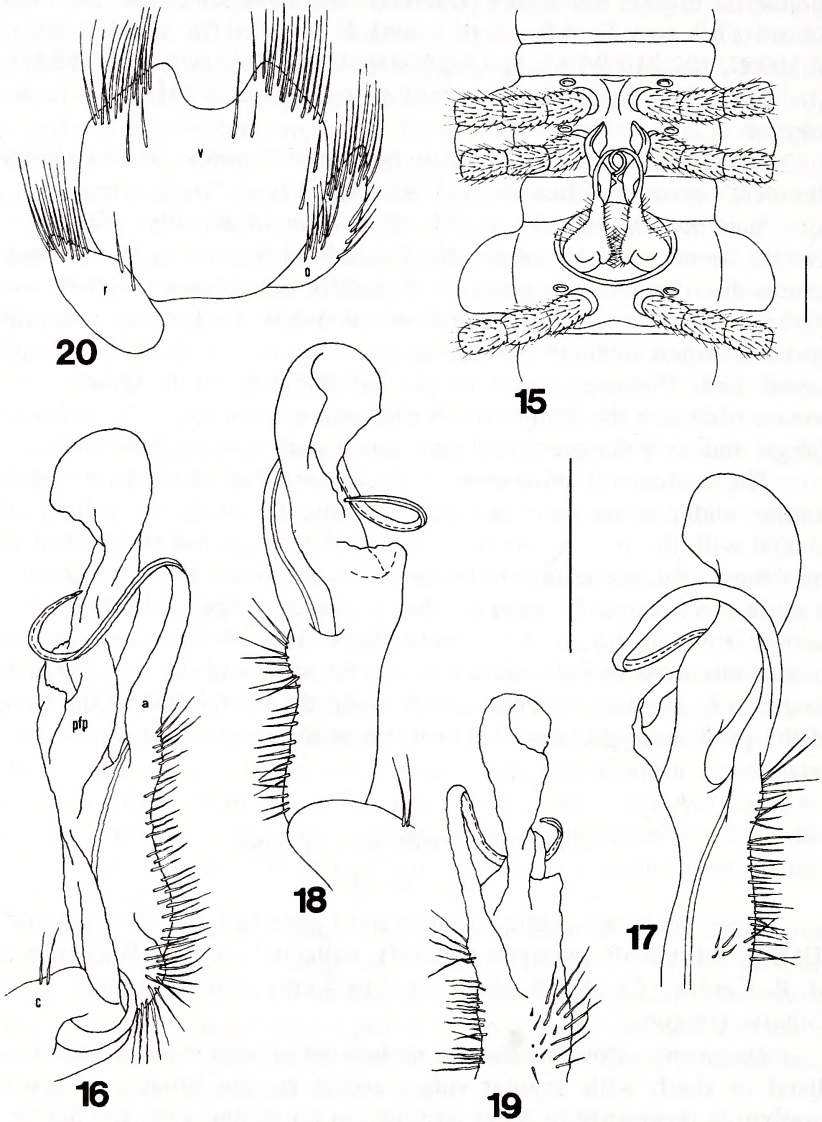


Fig. 15-20. *Chonaphe evexa*. 15, gonopods *in situ*, ventral view of paratype. 16, left gonopod of holotype, medial view. 17, telopodite of the same, dorsal view. 18, the same, lateral view. 19, the same, ventral view. 20, left cyphopod of female paratype, caudal view. Abbreviations as in Fig. 2-8. Scale line for Fig. 15 = 1.00 mm; line for other Fig. = 1.00 mm for 16-18, 1.20 mm for 19, 0.60 mm for 20.

Somatic features agreeing with those of *C. armata*, with following exceptions:

Epicranial suture faint, becoming more distinct and deeply impressed near termination above interantennal region. Width across genal apices 1.9 mm, interantennal isthmus 0.8 mm. Antennae reaching back to caudal margin of 3rd tergite, relative lengths of antennomeres 2>3>4>6>5>1>7. Genae with faint impressions. Facial setae as follows: epicranial 2-2, interantennal 1-1, frontal 1-1, genal 3-3, clypeal about 7-7, labral about 11-11.

Collum moderately broad, ends terminating just above those of succeeding tergite. Paranota moderately developed, broadest on segments 1–5, angling ventrolaterad and continuing slope of dorsum, anterior corners blunt on segments 2–3, rounded on remaining tergites, caudolateral corners with suggestions of teeth on 2–3, rounded on remaining segments. Peritremata moderately distinct, moderately elevated above paranotal surface; ozopores located near midlength, opening laterad.

Sides of metazonites smooth, without ridges or impressions. 4th sternum with two minute, widely segregated knobs; 5th sternum with two flattened ridges between 4th legs and moderate depression between 5th legs. Prefemor of legs on segments 14–17 with short, ventrodistal spines.

Gonopodal aperture without caudal extension between 9th legs, 1.0-mm wide and 0.5-mm long at midpoint, without indentations, anterior margin flush with metazonal surface, sides elevating caudad and continuing onto caudal margin. Gonopods *in situ* (Fig. 15, of paratype) with telopodites extending anteriad from aperture in parallel arrangement, overhanging 6th sternum. Gonopod structure as follows (Figs. 16–19): Coxae relatively small, with two macrosetae, sternum with a short lobe subtending each coxa. Prefemoral process arising from anterior margin, narrow basally and curving slightly bisinuately, expanding at 1/4 length into shelf, outer margin extending beyond shelf as translucent shield, latter angling upward and merging imperceptibly with lateral margin of stem, stem without distal projection, with curvilinear ridge angling distolaterad from level of shelf to near lateral margin, outer/lateral margin curving to broadly rounded apex, subterminal edge slightly inturned to subacuminate tip, inner margin broadly indented, apical margin curving downward to narrowly rounded tip. Acropodite arising from caudal edge of prefemur, looping around prefemoral process and curling above shelf, displaced distad, normally curling onto shelf and terminating behind shield.

Male paratypes—The male paratypes agree with the holotype in all particulars.

possible. Agreeing closely with males in somatic features, except paranota more strongly declined, creating appearance of more highly arched body. Valves (Fig. 20) relatively small, corners extending slightly ventrad for equal distances, subtending deep central depression, with dense hair patches arising from medial and lateral projections. Receptacle relatively small, flat, and inconspicuous, with long hairs arising from ventral margin, extending slightly beyond anterior and caudal surfaces of valves, but not cupped around latter.

Distribution—Known only from the type locality.

Remarks—This intriguing species exhibits several distinct somatic features. As shown by the lower W/L ratio, *C. evexa* is longer and narrower than either *C. armata* or *remissa*, a distinction that is made even more dramatic in side by side comparisons because of its smaller, more rounded paranota. The gonopodal aperture does not extend caudad between the 9th legs, in marked contrast to the conditions in both *C. armata* and *remissa*, and the gonopods are oriented slightly differently *in situ*. In *C. evexa*, the acropodite arises almost centrally on the caudal side, as opposed to a sublateral origin in the other species. Consequently, the telopodite is rotated slightly counter-clockwise and is situated differently on the coxa. Occurring in the Coast Range of southwestern Oregon, *C. evexa* is well isolated from the main generic distribution, as the most proximate locality for *C. armata*, in Benton County, is some 144 mi (230 km) to the north-northeast.

Chonaphe schizoterminalis, new species

Figs. 21–26

Type specimens—Male holotype, one female paratype, and an additional segment of a male with gonopods (MCZ) collected by R. V. Chamberlin on an unknown date at Springdale, Stevens County, Washington.

Diagnosis—Dorsal surface of prefemoral process without thickened projection distal to shelf, with angular, laminate flap overlapping shield; apical margin gently curved and continuing downward to acuminate termination on medial side, strongly divided with lateral side extending inward to subacuminate tip as dactyliform projection; shield connecting with inturned lateral margin.

Color in life—Unknown, specimens completely blanched by preservative.

Holotype—Length 16.1 mm, maximum width 2.9 mm, W/L ratio 18.0%, D/W ratio 82.8%.

Somatic features agree with those of *C. armata*, with the following

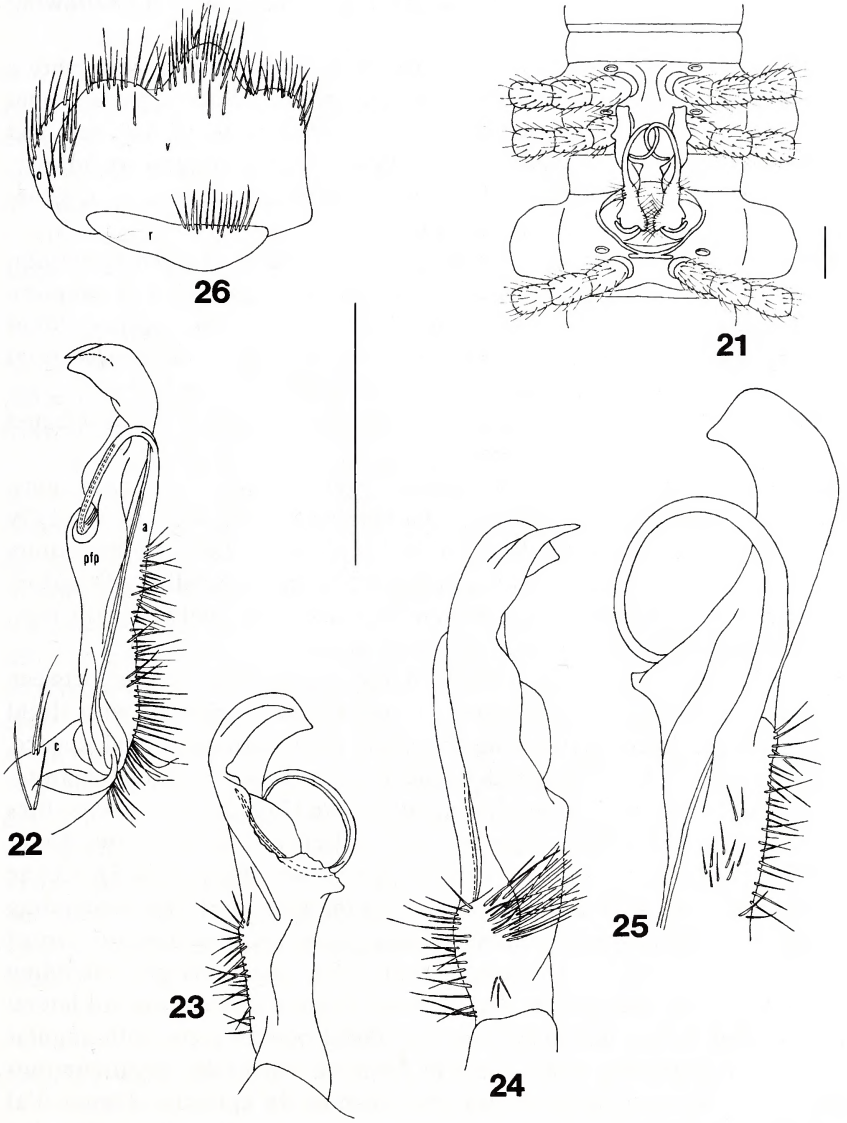


Fig. 21-26. *Chonaphe schizoterminalis*. 21, gonopods *in situ*, ventral view of paratype. 22, left gonopod of holotype, medial view. 23, telopodite of the same, dorsal view. 24, the same, lateral view. 25, the same, ventral view. 26, left cyphopod of female paratype, caudal view. Abbreviations as in Figures 2-8. Scale line for Figure 21 = 1.00 mm; line for other Figures = 1.25 mm for 22 and 24-25, 1.66 mm for 23, 1.00 mm for 26.

Somatic features agree with those of *C. armata*, with the following exceptions:

Epicranial suture thin but distinct, terminating just above interantennal region. Width across genal apices 2.2 mm, interantennal isthmus 0.5 mm. Antennae broken at articulations of 1st and 2nd articles. Genae with shallow central impressions. Facial setae as follows: epicranial 2–2, interantennal 1–1, subantennal 1–1, frontal 1–1, genal 3–3, dypeal about 12–12, labral about 16–16.

Collum broad, ends terminating above those of succeeding tergite. Paranota moderately developed, broadest on segments 1–5, angling ventrolaterad and continuing slope of dorsum, anterior corners blunt on segments 2–3, rounded at best on remaining tergites, caudolateral corners blunt on 2–3, rounded on remaining segments. Peritremata distinct, strongly elevated above paranotal surface; ozopores located near midlength, opening laterad.

Sides of metazonites with variable shallow grooves and impressions, without ridges. 4th sternum with two paramedial projections, medially coalesced, slightly longer than widths of adjacent coxae; 5th sternum with two shorter, widely segregated projections subtending 4th coxae, shorter than widths of latter, moderately depressed between 5th legs. Prefemora of all legs without traces of spines.

Gonopodal aperture extending slightly caudad over sternum between 9th legs, about 1.3-mm wide and 0.6-mm long at midpoint, with slight anteriolateral indentations, anterior margin flush with metazonal surface, sides elevating strongly caudad and continuing onto caudal margin, lowering slightly in midline. Gonopods *in situ* (Fig. 21) with telopodites extending anteriad from aperture in parallel arrangement, overhanging 6th sternum. Gonopod structure as follows (Figs. 22–25): Coxae relatively small, with 2 macrosetae; sternum with short lobe subtending each coxa. Prefemoral process arising from anterior margin, broad basally, expanding at 1/4 length into shelf, outer margin extending beyond latter as translucent shield, latter angling upward toward lateral margin and fading out imperceptibly, distal part of stem with angular laminate flap folding over shield to form enclosed tube, stem continuing distad, apically divided and curving broadly apically, distomedial margin strongly indented, distolateral margin expanding distad, leaning over stem, and continuing as acuminate dactyliform projection, subequal in length to that of medial margin. Acropodite arising from caudal margin of prefemur, looping above medial surface of prefemoral process and curling onto shelf, extending through enclosure formed by flap and shield, emerging distad and terminating behind inturned lateral margin.

Paratype gonopods—Agreeing with those of holotype in all details.

Female paratype—Length about 24.7 mm, maximum width 3.4 mm, W/L ratio 13.8%, D/W ratio 82.4%. Agreeing closely with male in somatic features, except paranota shorter and more strongly declined, creating appearance of more vaulted body. Valves (Fig. 26) moderate-size, hirsute along ventral margins with moderate-size lobes at midlength of ventral surfaces, without depressions. Receptacle small flat, and inconspicuous, located directly beneath valves, not cupped around sides of latter, with a few hairs from ventral margin.

Distribution—Known only from the type locality.

Remarks—Neither of the complete specimens is in good condition, having softened after years in preservative. There is also an additional, loose reproductive segment of a male with both gonopods intact. I have labeled these as "male paratype gonopods."

The smallest species, *C. schizoterminalis* is somewhat broader in proportion to its length than *C. evexa*. It is unique in the complete absence of prefemoral spines on the walking legs, and like *C. evexa*, the gonopodal telopodites are rotated counterclockwise on the coxa, in contrast to the condition in *C. armata* and *remissa*. However, *C. schizoterminalis* shares the caudal expansion on the aperture with the last two species. Northeastern Washington has been very poorly sampled, as most collectors have focused on the wet coastal forests west of the crest of the Cascades. Additional unexpected millipeds may therefore await discovery in the Okanogan, Colville, and Kaniksu National Forests in Okanogan, Ferry, Stevens, and Pend Oreille counties, and *C. schizoterminalis* could conceivably occur across the International Border near Rossland and Trail, British Columbia, only 71.5 mi (113.8 km) to the north. I visited the Springdale area in May 1993 to try to obtain more material, but encountered *C. armata*, not *C. schizoterminalis*, approximately 13.5 mi (21.6 km) west of the village along the Springdale to Hunters road.

Genus *Semionellus* Chamberlin

Semionellus Chamberlin, 1920:97. Attems, 1938:200. Chamberlin and Hoffman, 1958:47. Jeekel, 1971:287. Hoffman, 1979:157. Kevan, 1983:2968.

Type species—Polydesmus (*Leptodesmus*) *placidus* Wood, 1864, by original designation.

Diagnosis—Paranota present on all segments but becoming progressively less distinct caudad, caudal part of body appearing subcylindrical; epiproct without constriction; gonocoxae widely segregated by narrow sternal band, latter with lateral lobes; telopodal elements

subparallel for most of lengths, arising distad on prefemur; prefemoral process long, expanded and laminate, elaborately ornamented, with strong medial spine distal to midlength and numerous hairs on lateral surface and inner distal and apical margins; acropodite acicular, passing through essentially a single vertical plane, sublinear for most of length, lying over medial face of prefemoral process; cyphopod valves flattened ventrad, without lobes, projections, or cavities.

Description—A genus of moderate-size to large chonaphine Xystodesminae with the following characteristics:

Body composed of head and 20 segments in both sexes. Head of normal appearance, smooth. Epicranial suture sharp, distinct. Antennae relatively short and broad, with 4 conical, terminal sensory cones; no other sensory structures apparent. Facial setae with epicranial, subantennal, frontal, clypeal, and labral series; interantennal and genal absent.

Terga smooth, polished; strictures broad, distinct. Collum large and broad, terminating at same level as succeeding tergite. Paranota present on all tergites, becoming distinctly shorter around midbody and progressively more so caudad, moderately declined, continuing slope of dorsum. Peritremata distinct; ozopores opening sublaterad.

Caudal segments normal for family.

Sides of metazonites smooth, polished, with at most only shallow impressions. Pregonopodal sterna of males glabrous; 4th with two long, diverging projections, overhanging adjacent coxae; 5th with two short lobes between 4th legs, flattened between 5th; 6th sternum strongly depressed between both leg pairs. Postonopodal sterna glabrous, flat, and unmodified, with only shallow transverse grooves originating between leg pairs. Coxae unmodified; prefemora with broadly rounded, ventrodistal lobes, becoming progressively smaller caudad.

Gonopodal aperture large, subtrapezoidal, with broad caudal extension between 9th legs. Gonopods *in situ* with telopodites in parallel arrangement. Coxae with 2–5 macrosetae, connected to each other by narrow sternal band, latter with lobes subtending coxae. Telopodal elements subparallel for most of lengths, arising distad on prefemur; latter relatively broad; prefemoral process large, expanded and laminate, elaborately ornamented, with broad, cupulate, irregularly serrate basal flange, bending abruptly dorsad and expanding into lateral and another medial flanges, former marginally smooth, narrowing or expanding distad, with or without thickened margin, latter cupulate basally, curling around acropodite in some males, marginally irregular and with strong distal spine, stem of process narrowing then expanding greatly distal to flanges to subacuminate tip on inner, distal corner, inner margin and lateral surface hirsute, becoming progressively denser distad, distal

margin indented. Acropodite long, slender, and aciciular, demarcated from prefemur by strong constriction, bending anteriad basally, sublinear for most of length, curving broadly distad, about 3/4 as long as prefemoral process. Prostatic groove arising in pit in prefemur, running down medial side of latter and curving onto lateral side of acropodite, curving around latter and continuing to terminal opening.

Cyphopod aperture long and narrow, encircling 2nd legs, sides and caudal margin elevated above metazonal surface, more so medially. Cyphopods *in situ* with valves oriented transversely in aperture, common surface visible in opening. Valves moderate-size, moderately hirsute, without marginal extensions and central depression. Receptacle moderate-size, ventrally hirsute, located on dorsomedial side of valves, not alate and cupped around latter. Operculum large, located on dorsolateral side of valves, with long apical hairs.

Distribution—Occurring in four segregated areas east of the Central Plains including parts of Minnesota and Wisconsin; the lower peninsula of Michigan, northwestern Ohio, and Indiana; one site in eastern Ohio; and parts of Maryland, West Virginia, and Virginia.

Species—One.

Remarks—The only tribal component east of the Plains, *Semionellus* is evidence of prior faunal linkage through the gap of some 1,053 mi (1,684 km) in the northcentral United States. The Black Hills in western South Dakota, an island of forested mountains in the midst of intervening grasslands, is a plausible site for an undiscovered, relict, chonaphine population that might bridge anatomical gaps between *Semionellus* and *Chonaphe*. However, my field trip there in May 1986 produced only parajulids and introduced species, and disclosed no xystodesmids, possibly because of unseasonably cold weather (Shelley 1990). Hardwood-fir environments in this area, particularly in Spearfish Canyon, the north slope of Mount Harney, and the Iron Creek drainage above the Needles Section of Custer State Park, should be reinvestigated in warmer weather to ensure that the Black Hills do not harbor xystodesmids. Inselberg ranges in Montana east of the Continental Divide like the Big and Little Belt Mountains and the Absaroka and Bighorn Ranges are other plausible areas for undiscovered chonaphines that would be remnants of the ancient faunal connection.

Semionellus placidus (Wood)

Figs. 27–32

Polydesmus (*Leptodesmus*) *placidus* Wood, 1864:9; 1865:225, fig. 56.
Polydesmus (*Leptodesmus*) *floridus*, var.? Wood, 1864:9; 1865:226.

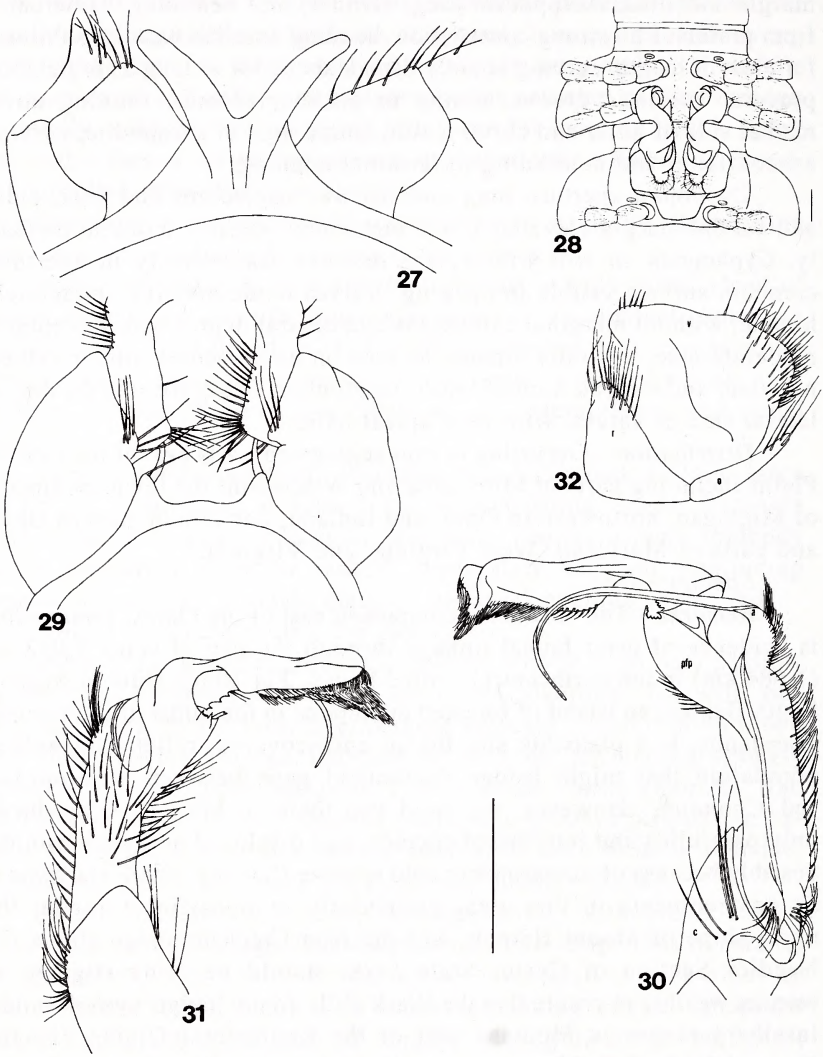


Fig. 27-32. *Semionellus placidus*. 27, 3rd sternum of male from Midland County, Michigan, caudal view. 28, gonopods *in situ*, ventral view of male from Tucker County, West Virginia. 29, gonocoxae and sternum of male from Midland County, Michigan, caudal view. 30, left gonopod of the same, medial view. 31, the same, lateral view. 32, left cyphopod of female from Pepin County, Wisconsin, caudal view. Abbreviations as in Fig. 2-8. Scale line for Fig. 28 = 1.00 mm; line for other Fig. = 1.40 mm for 27, 3.50 mm for 29-31, 1.00 mm for 32.

Leptodesmus placidus: Bollman, 1888:406; 1893:122. Carl 1903:549–551, Taf. 17, fig. 18. Williams and Hefner, 1928:110, fig. 11b.
Leptodesmus borealis Bollman, 1893:183–184.
Trichomorpha placida: Attems, 1938:119–120, fig. 139. Causey, 1952:9.
Chonaphe michigana Chamberlin, 1946:31–32, figs. 1-2.
Semionellus placidus: Chamberlin, 1947:24, fig. 3. Johnson, 1954:248, pl. III, fig. 19. Chamberlin and Hoffman, 1958:47–48. Kevan, 1983:2968.
Semionellus michiganus: Chamberlin, 1948:258.

Type specimen—Lost. The type locality is Michigan without further specification (Wood 1864, 1865).

Diagnosis—With the characters of the genus.

Color in life—Paranota red, metaterga black with concolorous red bands along the caudal margins.

Male from Midland County, Michigan (Holotype of C. michigana)—Length 28.3 mm, maximum width 4.8 mm, W/L ratio 16.7%, D/W ratio 77.1%.

Head capsule smooth, polished; epicranial suture distinct, terminating in interantennal region. Antennae appearing relatively short and broad, reaching back to caudal margin of 3rd tergite; relative lengths of antennomeres 2>3>6>4=5>1>7. Genae not margined laterally, with distinct central impressions, ends broadly rounded and extending slightly beyond adjacent cranial margins. Facial setae as follows: epicranial 2-2, interantennal, frontal, and genal not detected, clypeal about 10-10, labral about 14-14.

Collum moderately broad, ends not extending below those of succeeding tergite. Paranota well developed on anteriormost segments, becoming noticeably shorter on segment 9 and progressively shorter caudad, moderately declined, angling ventrolaterad and continuing slope of dorsum, anterior corners rounded, caudolateral corners blunt through segment 9, rounded thereafter. Peritremata broad, distinct, strongly elevated above apranotal surface; ozopores located caudal to midlength, opening sublaterad.

Sides of metazonites generally smooth, polished, with variably curved, shallow impressions. Strictures distinct. Gonapophyses moderately long and stout, extending moderately from 2nd coxa. Pregonopodal sterna glabrous, variably modified; 4th sternum with two long, diverging projections extending ventrolaterad and overlying 3rd coxa (Fig. 27); 5th sternum with two short, subconical, paramedian knobs between 4th legs, flat between 5th legs; 6th sternum strongly depressed to accommodate telopodites. Postgonopodal sterna glabrous, with bicruciform impressions, caudal margins gently curved, without modifications.

Coxae without projections; prefemora with broadly rounded lobes on outer surface, becoming smaller and less pronounced caudad; tarsal claws sublinear. Hypoproct broadly rounded, paraprocts with margins strongly thickened.

Gonopodal aperture very broad, subtrapezoidal, extending caudad between 9th legs and overhanging caudal margin of segment, with strong shelf in caudal extension, extending anteriad nearly to anterior margin of prozonum, latter with only thin sclerotized strip along anterior margin to maintain structural integrity, 2.4-mm wide and 2.1-mm long at midpoint, without indentations, sides elevated slightly above metazonal surface, inner margin continuing smoothly around bases of coxae, outer margin continuing into strong elevations along caudolateral and caudal margins, latter strongly thickened and slightly flared. Gonopods *in situ* (Fig. 28, not this specimen) with telopodites extending anteriad from aperture in parallel arrangement, overhanging 6th sternum. Gonopod structure as follows (Figs. 29–31): Coxa relatively large, with 2–5 macrosetae above cannula, connected to opposite member by narrow sternal band, latter with two moderate lobes subtending coxae. Prefemur relatively long and broad, expanding slightly distad, with large, laminate prefemoral process arising distad from anterior surface, expanded basally into broad, cupulate flange with strong spur on medial margin, several minute teeth in indentation on distal margin, and short, irregularly serrate projection laterally, stem of prefemoral process curving slightly then bending abruptly dorsad and expanding into second medial and a lateral flanges, medial flange widest basally and curving dorsad with minute marginal teeth and strong distal spine, lateral flange broadly rounded basally, extending distad into broad ledge overhanging tip, ledge with numerous short hairs, overhanging denser hairs on stem of prefemoral process, latter narrowing greatly distal to bases of flanges then expanding greatly on inner surface, inner margin hirsute and becoming progressively more so distad, expanding apically into subacuminate tip at inner distal corner, directed dorsad, apical margin broadly indented. Acropodite arising on caudomedial side of premur, demarcated by strong constriction, bending abruptly anteriad and continuing sublinearly parallel to stem of prefemoral process, curving broadly dorsad distally and narrowing to acuminate tip, overall length about 3/4 that of prefemoral process.

Female from Pepin County, Wisconsin—Length 27.4 mm, maximum width 4.4 mm, W/L ratio 16.1%, D/W ratio 84.1%. Agreeing closely with males in somatic details except paranota more strongly declined, creating appearance of more highly arched body. Cyphopods *in situ* with valves oriented transversely in aperture, common surface

visible in opening. Valves (Fig. 32) relatively large, subequal, ventral surfaces flat, without depression, margins not extended, moderately hirsute. Receptacle moderately large, located at dorsomedial corner of valves, not alate, not cupped around latter, with long hairs arising from ventral surface.

Variation—The only noteworthy gonopodal variation concerns the degree of serration on the medial flanges, which can be more or less than on the illustrated specimen and quite jagged on occasional males, and the thickness of the distolateral ledge, whose margin is thickened on some males and expanded slightly into a rim lying perpendicular to the axis of the prefemoral process. On a few males the acropodite lies closer to the stem of the prefemoral process, running through the curvature of the second medial flange. Facial setae on a male from Tucker Co., WV, are epicranial 2-2, interantennal absent, subantennae 1-1, frontal 1-1, clypeal about 12-12, labral about 18-18, merging with clypeal series and continuing for short distance along genal border, about 4 setae per side.

Ecology—I have collected *S. placidus* in West Virginia in deciduous forests and cove habitats under moist leaves near water sources.

Distribution—The only tribal representative occurring in the east, *S. placidus* inhabits four segregated areas. The western population traverses the Mississippi River in the Central Lowland Physiographic Province from southeastern Minnesota to southeastern Wisconsin and may not be contiguous, as linkage has not been demonstrated between the samples taken along the Mississippi and those in southern and eastern Wisconsin. The central population, also in the Central Lowlands, extends from the central part of the lower peninsula of Michigan, near the base of the "thumb," through western Ohio to western and south central Indiana. The eastern population, located in the Appalachian Plateau, Ridge and Valley, and Blue Ridge Physiographic Provinces, ranges from western Maryland through eastern West Virginia, to western Virginia, reaching its eastern periphery in Shenandoah National Park. There is also a single record from southeastern Ohio along the Ohio River. Approximate areas of the populations are 273 mi (437 km) east/west and 45 mi (72 km) north/south for the western, 245 mi (392 km) east/west and 332 mi (531 km) north/south for the central, and 98 mi (157 km) east/west and 137 mi (219 km) north/south for the eastern. The western and central populations are separated by around 156 mi (250 km), and the central and eastern populations are segregated by about 234 mi (374 km); the southeastern Ohio record is intermediate between the last two areas. No specimens have been encountered in

about 117 mi (187 km) from the closest site in Ontario, and *S. placidus* may eventually be discovered in Essex County, as was the rhysodesmine species *Pleuroloma flavipes* Rafinesque (Shelley 1988). However, in two days of searching in July 1986, including extensive investigations in Point Pelee National Park, I did not encounter it. Specimens were examined as follows:

MINNESOTA: *Rice Co.*, Northfield, Carleton College, M, F, Fall 1955, P. Jensen (VMNH). *Wabasha Co.*, Goodhue, Lake Pepin, 2M, 2F, 25 March 1931, W. J. Gertsch (VMNH). *Winona Co.*, 2 mi (3.2 km) NE Elba, F, 14 October 1973, B. Cutler (UMN); Whitewater St. Pk., M, 12 June 1961, H. W. Levi (MCZ); and Winona, juv., date unknown, Holzinger (NMNH). *Houston Co.*, Houston, M, 25 May 1940, C. E. Mickel (UMN).

WISCONSIN: *Pepin Co.*, Lake Pepin, 2M, 2F, 25 July 1931, W. J. Gertsch (NMNH). *Dane Co.*, Madison, M, 22 February 1914, A. S. Pearse (NMNH); and Bascom Woods nr. Madison, F, 30 September 1947, H. W. Levi (MCZ). *Ozaukee Co.*, Mud Lake, 2M, F, 9 April 1979, Hildebrandt, Plonczynski (MPM). *County Unknown*, "Bob's Cabin," 2M, 2F, 21 October 1973, P. Riemer (TMM).

MICHIGAN: *Midland Co.*, Midland, 2M, 25 May 1942 and 7 May 1943, R. R. Dreisbach (NMNH). *Ingham Co.*, East Lansing, Sanford Woodlot, M, F, 3 October 1955, collector unknown (FSCA). *Washtenaw Co.*, 5 mi (8.0 km) W Ann Arbor, M, 6 July 1948, G. C. Wheeler (FSCA). *Monroe Co.*, Monroe, 6M, 4F, July 1965, collector unknown (UCD).

INDIANA: *Benton Co.*, Boswell, M, F, date unknown, Mattier (NMNH). *Greene Co.*, Richland Cr., exact location unknown, 2F, 25 March 1952, collector unknown (FSCA). *Monroe Co.*, locality not specified, M, 12 August 1953, B. G. Owen (FSCA); Green's Bluff, exact location unknown, F, 1 November 1953, B. G. Owen (FSCA); along Wylie L., M, 12 July 1953, B. G. Owen (FSCA); and Morgan-Monroe St. For., 2F, 15 April 1952, collector unknown (FSCA). *Union Co.*, Whitewater St. Pk., 2F, 7 August 1953, B. G. Owen (FSCA).

OHIO: *Monroe Co.,* 1.8 mi (2.9 km) N Rinard Mills, nr. Knowlton Covered Bridge, F, 8 July 1986, D. R. Whitehead (NMNH).

MARYLAND: *Garrett Co.*, exact location unknown, M, July 1907, W. Stone, T. D. Keim, H. W. Fowler (ANSP).

WEST VIRGINIA: *Tucker Co.*, Lanesville, 5.5 mi (8.8 km) E WV hwy. 32, Monongahela Nat. For., 3M, F, 23 August 1978, R. M. Shelley, C. P. Withrow (NCSM); and Dolly Sods, 11M, 11F, 20 July 1986, D. R. Whitehead (NMNH). *Randolph Co.*, 2.1 mi (3.3 km) W Alpena, along US Hwy. 33, 14M, 5F, 23 August 1978, R. M. Shelley,

Alpena, along US Hwy. 33, 14M, 5F, 23 August 1978, R. M. Shelley, C. P. Withrow (NCSM); and S of Harman, along Dry Fork Rd., 7 mi (11.2 km) SW jct. Job Whitmer Rd., F, 23 June 1986, D. R. Whitehead (NMNH). *Pendleton Co.*, 4.5 mi (7.2 km) W Judy Gap, along Briery Gap Rd., M, 2F, 21 August 1988, D. R. Whitehead, L. A. Pereira (NMNH). *Pocahontas Co.*, Monongahela Nat. For., exact location unknown, M, 2F, 24 September 1972, W. A. Shear (WAS); and Hills Cr. Falls Scenic Area, along WV hwy. 55 E Greenbrier Co. line, F, 19 June 1972, W. A. Shear (WAS).

VIRGINIA: *Rockingham Co.*, 7 mi (11.2 km) NNW Rawley Springs, Tomahawk Mtn., F, 17 June 1988, K. A. Buhlmann (VMNH). *Warren Co.*, N end of Skyline Dr., Shenandoah Nat. Pk., M, 24 September 1943, collector unknown (NMNH). *Page Co.*, Luray, F, July 1966, C. Ewing (NCSM); Skyland, Shenandoah Nat. Pk., M, date unknown, J. P. E. Morrison (NMNH); and along Skyline Dr. at Stony Man Mtn., Shenandoah Nat. Pk., 7M, 3F, 29 May–11 June 1950, B. D. Burks (NMNH). *Page/Rappahannock Cos.*, along Skyline Dr., 1–2 mi (1.6–3.2 km) S Panorama, M, F, 21 June 1938, H. F. & E. M. Loomis (VMNH). *Madison Co.*, along Skyline Dr. above Hemlock Spgs. Overlook, Shenandoah Nat. Pk. 3M, 2F, 26 June 1953, L. Hubricht (VMNH); along Skyline Dr. at milepost 39, Shenandoah Nat. Pk., F, 13 July 1957, Highton, Barry (VMNH); and "Limberlost," Shenandoah Nat. Pk., 6M, 2F, 2 juvs., 27 May 1990, C. A. Pogue (VMNH). *Greene Co.*, along Skyline Dr. nr. milepost 71, Shenandoah Nat. Pk., F, 13 July 1957, Highton, Barry (VMNH). *Augusta Co.*, W side of Humpback Mtn., along Blue Ridge Pkwy. S of I-64, M, F, 17 June 1947, (VMNH). *Botetourt Co.*, nr. Sugarland, Apple Orchard Mtn., 2M, F, 27 May 1962, R. L. Hoffman (VMNH) and M, 14 October 1962, collector unknown (VMNH).

The following additional literature records are deemed valid and are denoted by open symbols in figure 69.

WISCONSIN: *Milwaukee Co.*, locality not specified (Causey 1952).

OHIO: *Allen*, *Hardin*, *Seneca*, and *Wood cos.*, localities not specified (Williams and Hefner 1928).

Deletions—The following literature records to either *S. placidus* or a synonym refer to other polydesmoids and hence are deleted.

KANSAS: *Jefferson Co.*, cited as *Polydesmus floridus* (Cragin 1885) and *Leptodesmus placidus* (Gunthorp 1913, 1921). No modern, authentic records are available from anywhere near Kansas, as shown in figures 1 and 69. These records of *P.* and *L. floridus* probably refer to a eurymerodesmid and were cited as such by Shelley (1989).

NEBRASKA: West Point, Roca, Rulo, and LaPlatte, cited as *L. floriaius* (Kenyon 1893*a*) and *L. floridus* (Kenyon 1893*b*). Shelley (1989) synonymized this usage of *L. floridus* with *E. mundus*.

GEORGIA: Ft. Benning (Chamberlin 1951). As noted by Shelley (1990), this record is a misidentification of *Oxidus gracilis* (Koch).

ILLINOIS: *Union Co.*, Rich's Cave near Cobden (Causey 1952). As this site is along the Mississippi River in southern Illinois, far from the range of *S. placidus*, this record of a juvenile surely refers to another xystodesmid.

Remarks—As noted by Shelley (1990), the northern- and western-most record of *S. placidus* is that from Rice County, Minnesota, and the southern- and eastern-most are in Botetourt and Madison counties, Virginia, respectively. These records span a distance of some 858 mi (1,381 km) in the east-west dimension and 429 mi (688 km) in the north-south. The Monroe County, eastern Ohio record, shown by a dot in figures 1 and 69, was obtained since my 1990 paper and lies nearly midway between the central and eastern faunal areas. This record may indicate the existence of a small additional population along the northern/western side of the Ohio River.

In addition to the narrower body, females of *S. placidus* can be distinguished from ones of other eastern taxa by the hirsute receptacle, as this cyphopodal structure is glabrous in the other eastern tribes.

Genus *Montaphe* Chamberlin

Montaphe Chamberlin, 1949:127. Chamberlin and Hoffman, 1958:38. Jeekel, 1971:273. Hoffman, 1979:157. Kevan, 1983:2968.

Type species—*Leptodesmus* (*Chonaphe*) *elrodi* Chamberlin, 1913, by original designation.

Diagnosis—Paranota present and distinct on all segments; epiproct without constriction; gonocoxae narrowly segregated by narrow sternal band, latter either with two paramedian lobes adjacent to coxae or single, broad, central lobe; telopodal elements parallel or subparallel for most of lengths, arising proximad on prefemur; prefemoral process variable, either long, extending well beyond acropodal loop, and narrowly blade-like, with strong distal barbules and a broad projection proximal to midlength, or short, terminating inside acropodal loop, and apically expanded and deeply divided; acropodite narrowly blade-like basally, acicular to subacicular distad, typically looping over prefemoral process, either without projections or expanding basally and with lateral spiniform projection; cyphopods with medial valves expanding gently to strongly ventrad, constituting at most only short lobes, subtending at most only moderate central cavity.

Description—A genus of moderately large chonaphine Xystodesminae with the following characteristics.

Body composed of head and 20 segments in both sexes, essentially parallel sided, tapering at both ends.

Head of normal appearance, smooth, polished. Epicranial suture faint or distinct, terminating above epicranial region. Antennae relatively short and broad, becoming progressively more hirsute distad, with 4 conical sensory cones on ultimate anticle, no other sensory structures apparent. Genae not margined laterally, with faint or distinct central impressions, ends broadly rounded and extending slightly beyond adjacent cranial margins. Facial setae with epicranial, genal, clypeal, and labral series, with or without frontal and subantennal series, without interantennal series.

Terga smooth, polished. Collum broad. Paranota well developed, broadest on anteriormost segments, moderately declined, angling ventrolaterad and continuing slope of dorsum, anterior corners rounded, caudolateral corners variable, either blunt, squared, rounded, or angling caudad. Peritremata distinct; ozopores located caudal to midlength. Caudal segments normal for family.

Sides of metazonites smooth or granular, with or without variable ridges above leg coxae. Strictures broad but distinct. Gonapophyses moderately long and stout, extending moderately from 2nd coxae. Pregonopodal sterna glabrous; 5th sternum with or without low elevations between anterior (4th) legs, with moderate depression between 5th legs; 6th sternum strongly depressed between both legs to accommodate stems of telopodites. Postgonopodal sterna glabrous, unmodified. Coxa and prefemora with or without short projections on certain legs; tarsal claws gently curved. Hypoproct broadly rounded, paraprocts with margins strongly thickened.

Gonopodal aperture ovoid, extending caudad between 9th legs, with or without slight anteriolateral indentations, anterior margin and sides flush with metazonal surface, caudal margin elevated. Gonopods *in situ* with telopodites extending generally forward in subparallel arrangement, overhanging 6th and caudal half of 5th sterna. Coxae moderate-size, with macrosetal tufts above and below cannula, narrowly segregated by narrow sternal band, with either two lateral or one central lobes. Telopodal elements parallel or subparallel for most of lengths, arising basally from prefemur; latter relatively long and slender; prefemoral process narrow and blade-like basally, curving anteriad at midlength to 2/3 length, with or without broad, toothed projection from anterior surface proximal to curve, either expanding distad into deeply divided, bifurcate termination, or blade-like, extending sublinear-

ly and curving apically to subacuminate tip, with or without variable numbers of long, slender barbules scattered along stem distal to midlength curve and clustered apically. Acropodite either acicular, looping over prefemoral process, and without projections, or expanding near midlength and with broad spiniform projection, stem looping thereafter and becoming subacicular. Prostatic groove arising in pit in prefemur, running along medial surface of prefemur onto dorsal or inner surface of acropodite, continuing to terminal opening.

Cyphopodal aperture broad, encircling 2nd legs, sides and caudal margin elevated above metazonal surface. Cyphopods *in situ* with valves oriented transversely in aperture, common surface visible in aperture. Valves variable in size, subequal, lightly to moderately hirsute, medial corners gently to strongly extended, subtending slight to moderate central depression. Receptacles moderate-size, alate, with long hairs arising from ventral margin. Operculum moderate-size to large, located lateral to valves.

Distribution—Occurring in the western periphery of the Columbia Plateau Physiographic Province in central Washington and the northern Rocky Mountains and envirous from eastern Washington to western Montana.

Species—Two.

Remarks—I (Shelley 1990) stated that in western Canada, the Xystodesmidae did not occur east of the crest of the Cascade Mountains, although there was an outside possibility that the family might be found around Rossland and Trail where the forests seem more moist and extensive. As *Montaphe* is now known less than 5 mi (8.0 km) south of the International Border in Idaho, it seems certain that this genus is represented in the adjoining part of the interior of British Columbia.

As envisioned here, *Montaphe* is heterogeneous; the only features shared by both component species is the rust color, the narrowly segregated gonocoxae, and the general curvature pattern of the elements of the telopodite. To some degree, *M. paraphoena* represents an abbreviated or shortened version of *M. elrodi*, with the prefemoral process terminating before the acropodal loop rather than after. The acropodite of *M. paraphoena* is much broader and the only one in the tribe with a secondary projection, but I think the general pattern of the gonopodal elements of *M. paraphoena* is similar enough to that of *M. elrodi* to be accommodated at least temporarily under the same genus, as opposed to erecting another monotypic taxon. The two species are roughly 115.5 mi (184.8 km) apart, and the substantial anatomical differences suggest that additional forms may await discovered in central Washington.

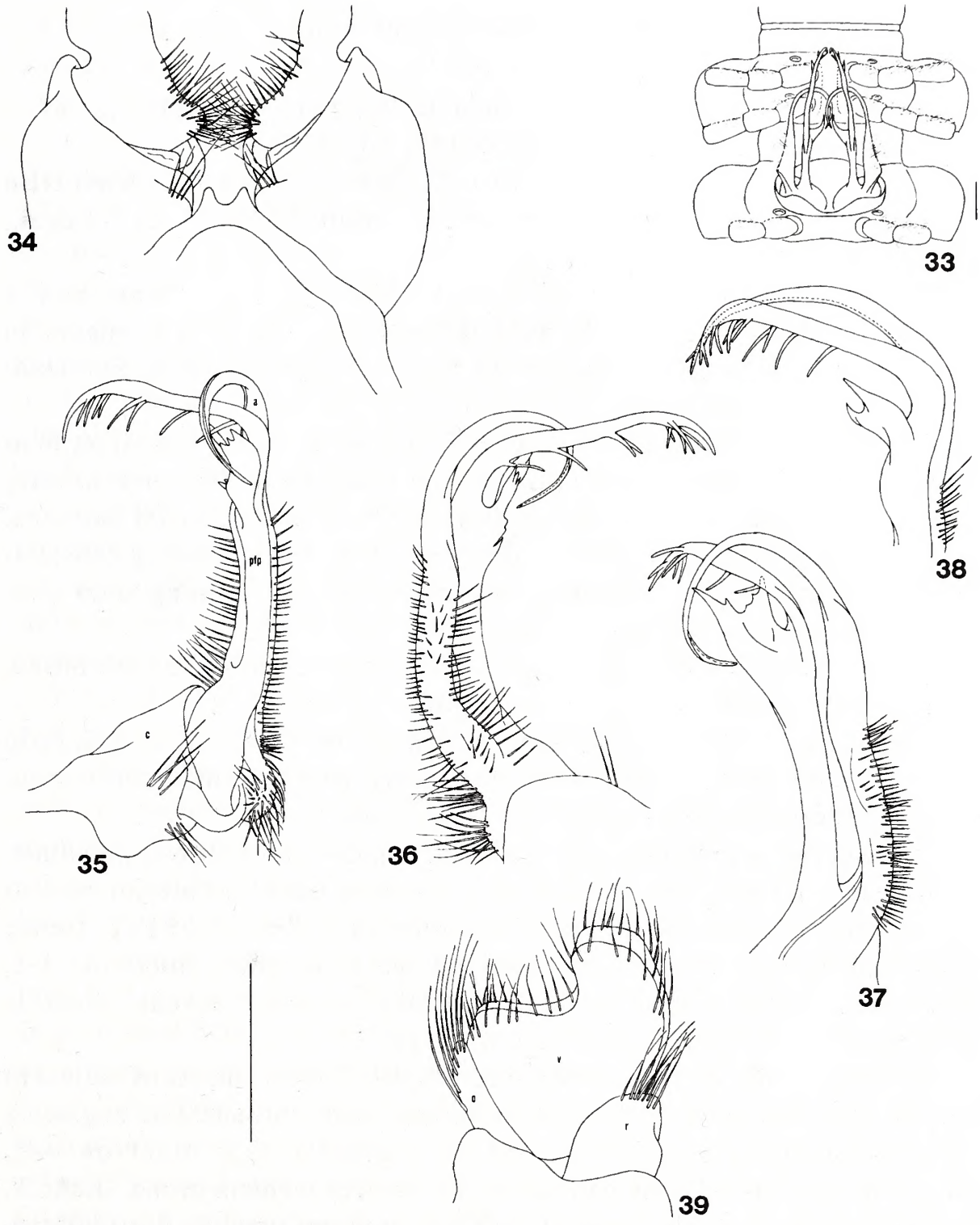


Fig. 33-39. *Montaphe elrodi*. 33, gonopods *in situ*, ventral view of male from Spokane County, Washington. 34, gonocoxae and sternum, caudal view of male syntype. 35, left gonopod of the same, medial view. 36, telopodite of the same, lateral view. 37, the same, subventral view. 38, distal extremity of telopodite of male from Pend Oreille County, Washington, medial view. 39, right cyphopod of female syntype, caudal view. Abbreviations as in Fig. 2-8. Scale line for Fig. 33 = 1.00 mm; line for other Fig. = 1.06 mm for 34 and 36, 1.00 mm for 35 and 37-39.

Montaphe elrodi (Chamberlin)
Figs. 33–39

Leptodesmus (*Chonaphe*) *elrodi* Chamberlin, 1913:424–426, fig. 17.
Amphelictogon elrodi: Attems, 1938:159, fig. 179.
Montaphe elrodi: Chamberlin, 1949:127. Causey, 1954*b*:82. Chamberlin and Hoffman, 1958:38. Loomis and Schmitt, 1971:113–114. Kevan, 1983:2968.

Type specimens—Male lectotype (NMNH) and 9 male and 4 female paralectotypes (MCZ, NMNH) collected by C. C. Adams in the summer of 1912 at an unknown site on Flathead Lake, Flathead/ Lake counties, Montana.

Diagnosis—Prefemoral process long and narrow, blade-like, bent abruptly dorsad near midlength, with broad, irregular, and usually subdivided projection proximal to bend and 5–13 strong, distal barbules; acropodite narrowly blade-like basally, acicular distad, narrowing constantly throughout length, without projections, usually looping over prefemoral process near bend of latter.

Color in life—Paranota rust-colored, metaterga black with broad, rust-colored bands along caudal margins.

Lectotype—Length 27.5 mm, maximum width 4.1 mm, W/L ratio 14.9%, D/W ratio 70.7%. Body essentially parallel sided throughout length, tapering at anterior and posterior ends.

Head capsule smooth, polished; epicranial suture shallow, indistinct. Antennae relatively short and broad, reaching back to anterior part of 4th tergite; relative lengths of antennomeres 2>3=4=5>6>1>7. Genae with faint central impressions. Facial setae as follows: epicranial 1-1, interantennal and frontal not detected and presumed absent, genal 1-1, clypeal about 10-10, labral about 12-12.

Collum broad, ends extending slightly below those of adjacent tergite. Paranota well developed throughout body, broadest on segments 1–6, caudolateral corners squared on segments 2–3, blunt on 4–5, rounded on 6–16, angling caudad on 17–18. Peritremata broad, distinct, strongly elevated above paranotal surface; ozopores opening dorsolaterad.

Sides of metazonites smooth, polished. 5th sternum moderately depressed between caudal (5th) legs to accommodate apices of telopodites. Postgonopodal sterna with broad, shallow central impressions and narrow transverse grooves originating between leg pairs, caudal margins gently curved. Coxae and prefemora without projections.

Gonopodal aperture ovoid, 1.7-mm wide and 0.6-mm long at midpoint, without indentations, sides and anterior margin flush with segmental surface, caudal margin strongly elevated into two broadly rounded, caudolateral lobes, lower in midline. Gonopods *in situ* (Fig.

33, not this specimen) with telopodites extending anteriad from aperture and overhanging anterior margin, acropodites curling mediad dorsal to prefemoral processes and overlaying each other in midline, prefemoral processes angling toward each other and extending forward over 6th sternum, apices bent dorsad. Gonopod structure as follows (Figs. 34–37): Coxa moderate size, with macrosetal tufts above and below cannula, narrowly separated from opposite member and connected by narrow sternum, latter with small paramedian lobes subtending coxae. Prefemoral process long and narrow, arising basally on medial side and extending forward in sublinear fashion, with broad, cupulate medial projection at 1/3 length, latter narrow basally then expanding broadly with 5 sharply acute teeth, 2 basally and 3 distad, and a second, more distal projection, also with terminal teeth, arising from the first, stem of prefemoral process bent strongly dorsad at 2/3 length, extending sublinearly and curving downward distad, apically subacuminate, with 8 slender barbules arising from inner margin distal to dorsal bend, spaced more or less equidistantly, clustered at distal curve. Acropodite arising lateral to prefemur, long, slender, and acicular, looping over prefemoral process at level of caudal bend, curling over medial surface of latter and overhanging medial projection, apically acuminate.

Male paralectotypes—The medial projection of the prefemoral process varies with more or fewer teeth than in the lectotype. The number of barbules varies from 5–13, which are generally clustered distad near the distal curve and evenly spaced back to the bend at 2/3 length. One paralectotype has a barbule proximal to the bend.

Female paralectotype—Length 23.6 mm, maximum width 4.5 mm, W/L ratio 19.1%, D/W ratio 80.0%. Agreeing closely with lectotype in structural details except paranota slightly shorter and more declined, creating appearance of more vaulted body. Valves (Fig. 39) moderately large and subequal, moderately hirsute, medial corners extending ventrad well below level of lateral corners, subtending central cavity. Receptacle relatively small, alate, cupped below medial corner of valves, extending slightly up anterior and caudal surfaces of latter, with long hairs arising from ventral margins. Operculum large, located laterad to valves.

Variation—As in the paralectotypes, variation among nontypical males primarily involves the configuration of the medial projection of the prefemoral process and the number and arrangements of barbules. The medial projection is flattened and plate-like in some males, while it is lobate in others; in the western part of the range its margins are smoother and less serrate than in the types (Fig. 38). The barbules vary as in the paralectotypes, clustering distad, being rather evenly spaced proximad, and typically arising distal to the bend at 2/3 length.

Additionally, the acropodite occasionally does not loop over the prefemoral process, but lies roughly parallel to it (Fig. 38).

Ecology—According to labels with preserved samples, *M. elrodi* has been encountered in a field under stones and logs, under rocks, and in moss near a small woodland stream. The specimens that I collected in Boundary and Bonner counties, Idaho, were found in moist deciduous litter in hardwood patches in predominantly coniferous forests; those from Idaho County were taken from litter in a ditch beside a walkway in a large area of deciduous trees; and that from Pend Oreille County, Washington, was encountered under a log and rock on a talus slope in a cool, moist cove along a stream. Loomis and Schmitt (1971) encountered the milliped between and under rocks, moss, logs, cedar bark, in rotten wood, between rocks just above the splash zone of cascading water in a stream, at the base of a talus slide, and in a red cedar, Douglas-fir forest. Sites were typically in creek bottoms with thick humus layers, and a number of specimens were taken in cedar groves.

Distribution—Spokane and Stevens counties, Washington, to Lake County, Montana, and from just south of the International Border in Boundary County, Idaho, and Pend Oreille County, Washington, to northern Idaho County, Idaho, north of the transverse stretch of the Salmon River. The area is approximately 242 mi (387 km) in the east-west dimension and 216 mi (346 km) in the north-south. The Whitman County, Washington, record is from the Columbia Plateau, and most of the other sites are in the Northern Rocky Mountains Physiographic Province. Specimens were examined as follows:

WASHINGTON: *Pend Oreille Co.*, ca. 4 mi (6.4 km) N Metaline Falls, along feeder stream to Sullivan Cr., ca. 1.7 mi (2.7 km) E WA hwy. 31, M, 31 May 1993, R. M. Shelley (NCSM); ca. 9 mi (14.4 km) SSE Metaline Falls, Noisey Cr. Cpgd., Sullivan L., 2M, 2F, 10 July 1988, R. W. Baumann, Wells, Whiting (BYU); and Gypsy Meadow NE Metaline Falls, 48.903°N, 117.080°W, F, 13 June 1986, R. Crawford (UWBM). *Spokane Co.*, Four Lakes, Granite L., 3M, F, 30 May 1947, M. H. Hatch (FSCA); Mt. Spokane St. Pk., Deadman Cr., F, 10 July 1988, R. W. Baumann, Wells, Whiting (BYU); and Spokane, M, F, 22 July 1882, S. Henshaw (MCZ). *Whitman Co.*, Ewan, 3M, F, 27 August 1932, M. H. Hatch (FSCA, UWBM).

IDAHO: *Boundary Co.*, 4 mi (6.4 km) SW Porthill, along Canyon Cr., 2M, 3F, 12 August 1991, R. M. Shelley (NCSM). *Bonner Co.*, 7.5 mi (12.0 km) N Priest River, along ID hwy. 57, M, F, 11 August 1991, R. M. Shelley (NCSM). *Shoshone Co.*, N Kellogg, 1.3 mi (2.0

km) up Steamboat Cr. from Coeur d'Alene R., 8M, 3F, 15 May 1975, F. W. Grimm (CMN). *Clearwater Co.*, 5.2 mi (8.3 km) N, 0.5 mi (0.8 km) E Headquarters, 4M, 9 July 1978, A. K. Johnson (NCSM); and 8.7 mi. (13.9 km) E, 5.7 mi. (8.0 km) N Pierce, French Mtn. Rd., 19M, 17F, 2 and 4 July 1978, A. K. Johnson (NCSM). *Idaho Co.*, 13 mi (20.8 km) SSE Pierce, Eldorado Ridge, M, 12 July 1978, A. K. Johnson (NCSM); 4 mi (6.4 km) SW Lolo Pass, US hwy. 12 at Russian Cr., 11M, 11F, 3 September 1978, A. K. Johnson (NCSM); 11 mi (17.6 km) SW Lolo Pass, along US hwy. 12, M, 25 June 1968, G. B. Wiggins, Yamamoto, Smith (ROM); 24.3 mi (38.9 km) E Lowell, along US hwy. 12, 3M, 3F, 10 June 1981, R. M. and S. B. Shelley, P. D. Hardister (NCSM); Lowell, M, 2F, 4 July 1949, C. O. Bowles, (NMNH); 1.1 mi (1.8 km) S Stites, Nez Perce Ind. Res., M, 15 May 1975, F. W. Grimm (CMNH); and 3 mi (4.8 km) E Syringa, Middle Fork Clearwater R., 2M, F, 15 May 1975, F. W. Grimm (CMN).

MONTANA: *Sanders Co.*, 1 mi (1.6 km) W Noxon, 3M, 4F, 2 May 1965, R. Schmitt (FSCA). *Missoula Co.*, Clinton, Hell Gate Run, 3M, 3F, August 1930, collector unknown (NMNH). *Flathead Co.*, Big Fork, M, F, 24 August 1957, H. W. and L. L. Levi (MCZ). *Flathead/ Lake cos.*, along Flathead L., 4M, F, 22 June 1909, collector unknown (EIL); and Flathead L., 10M, 4F, summer 1912, C. C. Adams (MCZ, NMNH) TYPE LOCALITY. *Lake Co.*, 6 mi (9.6 km) E St. Ignatius, Mission Cr. Canyon, 4M, 3F, 2 September 1978, A. K. Johnson (NCSM).

The following additional literature records are considered valid and are denoted by open symbols in figure 68. Those from Idaho and Montana are by Loomis and Schmitt (1971).

WASHINGTON: *Stevens Co.*, Evans (Causey 1954*b*).

IDAHO: *Idaho Co.*, 3.1 mi (5.0 km) W Surveyor Cr.

MONTANA: *Lake Co.*, along Big Fork River and North Crow, Dog, Jocko, Schmidt, and Hell Roaring Creeks; canyon near Mission Falls; St. Ignatius and 4.0 mi (6.4 km) E St. Ignatius; 8.5 mi (13.6 km) SE Swan Lake guard station; along Goat Cr., 10.0 mi (16.0 km) S Swan Lake; along Big Knife Cr., 5.0 mi (8.0 km) from Arlee; Methodist Camp, Rollins; McDonald Peak; Mission and McDonald cirques; Lake Mary Ronan; and Yellow Bay. *Missoula Co.*, along Smith Cr. near Condon ranger station; 1.0 mi (1.6 km) below Smith Cr.; along Crazy Horse Cr.; Pattee Cyn. Rec. Area; along Miller Cr. and Mt. Sentinel, Missoula; and along Nine Mile Cr., Huson.

Remarks—The black base color of *M. elrodi* is restricted to the prozonum and a narrow area on the anterior edge of the metaterga, so the rust-colored bands cover most of the latter and dominate the milliped's appearance. At first glance, it appears almost uniformly rust colored.

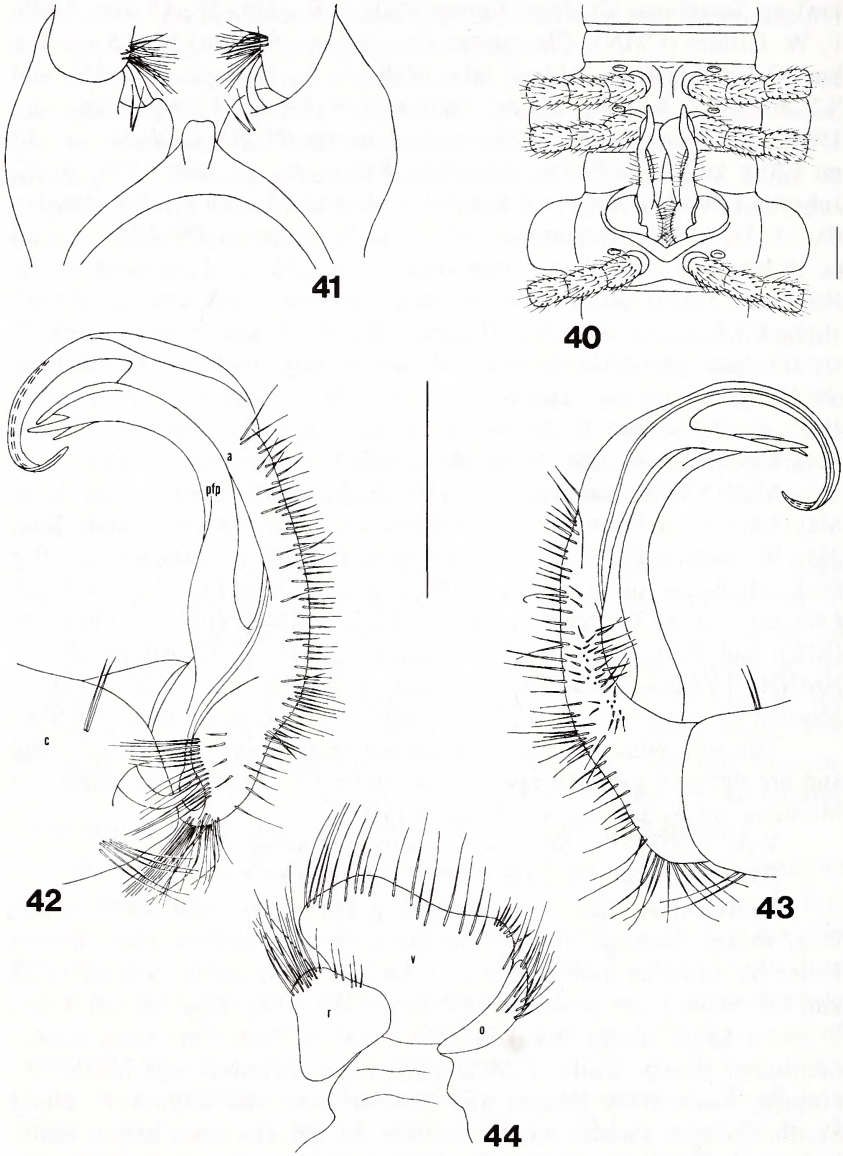


Fig. 40-44. *Montaphe paraphoena*. 40, gonopods *in situ*, ventral view of paratype. 41, gonocoxae and sternum, caudal view of paratype. 42, left gonopod of holotype, medial view. 43, the same, lateral view. 44, left cyphopod of female paratype, caudal view. Abbreviations as in Figs. 2-8. Scale line for Fig. 40 = 1.00 mm; line for other Figs. = 3.20 mm for 41, 2.22 mm for 42-43, 1.00 mm for 44.

In August 1991 I visited Glacier National Park and searched for *M. elrodi* at lower elevations on the west side of the Park, near Apgar, McDonald Lake, and the cedar grove near Avalanche Campground. As with Loomis and Schmitt (1971), I did not encounter *M. elrodi* in these areas or in regions outside the Park near Whitefish, Columbia Falls, and Hungry Horse Reservoir. The species therefore seems to be absent from areas north/northeast of Flathead Lake.

Montaphe elrodi is the dominant species in the eastward xystodesmid faunal extension into western Montana. Extremely abundant between eastern Washington and Flathead Lake, *M. elrodi* is now known from about 3 mi (4.8 km) south of the International Border near Porthill, Boundary County, Idaho, and should therefore be expected near Creston, British Columbia, only about 7 mi (11.2 km) north of Porthill. Records from Metaline Falls, Pend Oreille County, and Evans, Stevens County, Washington, are only about 10 and 20 mi (16 and 32 km) south of the border and suggest the occurrence of *M. elrodi* near Walneta and Nelway, British Columbia. It may also occur near Rossland and Trail, although they are just west of the Columbia River, which may constitute a distributional barrier. When collected, *M. elrodi* will represent a new genus and species for Canada.

Montaphe paraphoena, new species

Figs. 40–44

Type specimens—Male holotype and 13 male, 6 female, and 1 juvenile paratypes (UWBM) collected by R. Crawford, K. Dorweiler, and J. P. Pelham, 27 April 1991, in Tichenal Canyon, 7.5 mi (12.0 km) south, 1.5 mi (2.4 km) east of Waterville, (47.540°N, 120.035°W), Douglas County, Washington. One male and one female paratypes deposited in the NCSM.

Diagnosis—Prefemoral process short, expanding distad to irregular, deeply divided, bi-lobed termination within curvature of acropodite; latter expanding basically with thickened medial margin and spiniform lateral projection, narrowing thereafter, becoming subacicular apically.

Color in life—Paranota rust-colored, metaterga black with broad, rust-colored bands along caudal metatergal margins.

Holotype—Length 23.6 mm, maximum width 4.1 mm, W/L ratio 17.4%, D/W ratio 78.0%.

Somatic features agreeing with those of *M. elrodi*, with following exceptions:

Epicranial suture distinct, accentuated by narrow black line. Width across genal apices 2.6 mm, interantennal isthmus 0.9 mm. Relative lengths of antennomeres 2>3>6>4>5>1>7. Genae with distinct central

impressions. Facial setae as follows: epicranial 2-2, interantennal not detected and presumed absent, subantennal 1-1, frontal 1-1, genal 4-4, clypeal about 30-30, labral about 16-16.

Sides of metazonites granular, with ventral ridges just above leg coxae on segments 1–14, higher and more distinctly elevated above metazonal surface on segments 1–4, becoming progressively lower caudad. 5th sternum with two low, widely segregated, paramedian knobs between anterior (4th) legs, shorter than widths of adjacent coxae, and moderate depression between 5th legs. Coxae with small medial lobes on legs 3–5; prefemora with short, indistinct ventrodistal spines on legs on segments 10–16.

Gonopodal aperture generally ovoid, extending slightly caudad between 9th legs, 1.6-mm wide and 0.9-mm long at midpoint, indented slightly anteriolaterad, anterior margin and sides flush with metazonal surface, caudal margin becoming elevated at caudolateral corner, rising slightly to midline. Gonopods *in situ* (Fig. 40, of paratype) with telopodites extending generally anteriad from aperture and overhanging 6th sternum, acropodites and prefemoral processes angling toward each other and overlapping in midline. Gonopod structure as follows (Figs. 41–43). Coxa moderately large, with 2 dorsal and 4 ventral macrosetae, narrowly segregated from opposite member by narrow sternal band, latter with medial lobe. Prefemoral process short and broad, arising from dorsal surface, curving broadly at 2/3 length and expanding distad, deeply divided apically and terminating inside loop of acropodite in two acuminate determinations, medial one broader. Acropodite arising ventrad on prefemur, curving over prefemoral process in subparallel arrangement, expanding broadly with thickened medial margin and with strong projection from lateral surface distal to midlength, latter spiniform, extending nearly to level of terminus of prefemoral process, stem of acropodite narrowing slightly distad and looping dorsad beyond terminus of prefemoral process, curling to acuminate tip.

Male paratypes—The male paratypes agree with the holotype in all particulars.

Female paratype—Length 25.6 mm, maximum width 4.0 mm, W/L ratio 15.6%, D/W ratio 87.5%. Agreeing essentially with the males in somatic features except paranota more strongly declined, creating appearance of more vaulted body. Valves (Fig. 44) small, subequal, lightly hirsute, becoming slightly higher mediad but without distinct lobes or projections, slightly depressed centrally. Receptacle small, alate, cupped around medial side of valves, with long hairs arising from outer surface. Operculum relatively large, located laterad to valves.

Ecology—The types were found under rocks on soil on a barren slope in a heavily grazed, grassland area.

Distribution—Known only from the type locality, which is on the eastern side of Badger Mountain and in the western periphery of the Columbia Plateau Physiographic Province.

Genus *Tubaphe* Causey

Tubaphe Causey, 1954*a*:222. Chamberlin and Hoffman, 1958:52. Jeekel, 1971:291. Hoffman, 1979:159. Kevan, 1983:2968.

Type species—*Tubaphe levii* Causey, 1954, by original designation.

Diagnosis—Paranota present only on segments 1–4, remaining segments appearing nearly juloid, with at most only slight ozopore swellings; epiproct with distal constriction; gonocoxae narrowly segregated, attached by membrane only, without trace of sclerotized band; telopodal elements diverging, not parallel, prefemoral process arising near midlength of prefemur, acropodite arising distad; prefemoral process subacicular, gently curved, with minute distal barbules; acropodite narrowly blade-like to subacicular, in form of broad, open loop curving through a single vertical plane; cyphopod valves with medial corners projecting distinctly ventrad, subtending central cavity.

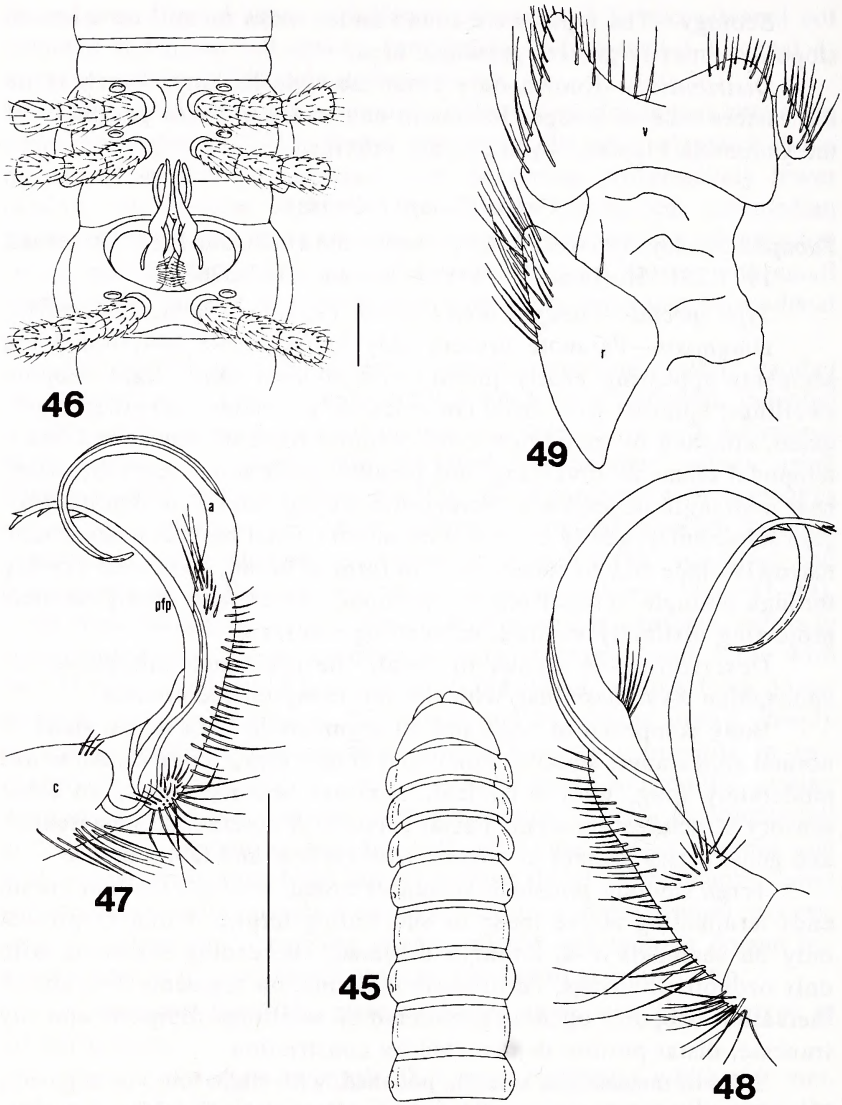
Description—A genus of small, narrow, and subcylindrical chonaphine Xystodesminae with the following characteristics.

Body composed of head and 20 segments in both sexes. Head of normal appearance, smooth. Epicranial suture sharp, distinct. Antennae moderately long, with 4 conical, terminal sensory cones, no other sensory structures apparent. Facial setae with epicranial, subantennal, and genal series present or absent, with clypeal and labral series.

Terga smooth, polished; strictures broad, distinct. Collum broad, ends terminating above those of succeeding tergite. Paranota present only on segments 1–4, strongly declined, succeeding segments with only ozopore swellings. Peritremata indistinct on segments 2–4, absent thereafter; ozopores opening sublaterad on swellings. Epiproct apically truncate, distal portion demarcated by constriction.

Sides of metazonites smooth, polished, with slight lobes on segments 2–4. Pregonopodal sterna glabrous, without modifications, strongly depressed on segment 6. Postgonopodal sterna glabrous, flat, and unmodified, with only shallow transverse grooves originating between leg pairs. Coxae with short tubercles on legs of segments 7–14; prefemora with ventrodistal spines on legs of segments 9–18.

Gonopodal aperture ovoid, without caudal extension. Gonopods *in situ* with telopodites in parallel arrangement. Coxae with macrosetae varying from 2–10 in two tufts, above and below cannula, attached by



Figs. 45-49. *Tubaphe levii*. 45, profile of anterior segments of male from Jefferson County, Washington, dorsal view. 46, gonopods *in situ*, ventral view of male from Vancouver Island, British Columbia. 47, left gonopod of male from Jefferson County, Washington, medial view. 48, telopodite of the same, lateral view. 49, left cyphopod of female from Jefferson County, caudal view. Abbreviations as in Figs. 2-8. Scale line for Fig. 46 = 1.00 mm; line for other Figs. = 0.5 mm for 45, 1.00 mm for 47-48, 1.30 mm for 49.

membrane only, without trace of sternal band. Telopodal elements diverging, not parallel; prefemur long and narrow; prefemoral process arising near midlength of prefemur, long, narrow, and subacicular, gently curved, extending beyond level of distal extremity of acropodal curvature, with 3–4 minute, distal barbules. Acropodite arising distad on prefemur, long and narrow, blade-like to subacicular, demarcated from prefemur by narrow constriction, configuration a broad, open loop curving over prefemoral process to acuminate tip. Prostatic groove arising in pit on prefemur, angling to lateral side of prefemur and extending onto base of acropodite, continuing to terminal opening.

Cyphopod aperture relatively narrow, encircling 2nd legs, sides and caudal margin elevated above metazonal surface. Cyphopods in situ with valves oriented transversely, common surface visible in aperture. Valves relatively large, subequal, and lightly hirsute, medial corners extending strongly ventrad, subtending deep central cavity. Receptable moderate-size, subtriangular, located below medial corners of valves, not cupped around latter, with numerous long hairs. Operculum large, located lateral to valves, with numerous long hairs.

Distribution—Along the Pacific Coast on the southwestern periphery of Vancouver Island, British Columbia, and on the western and southwestern slopes of the Olympic Mountains, Washington.

Species—One.

Tubaphe levii Causey

Figs. 45–49

Tubaphe levii Causey, 1954*a*:223, figs. 2–4. Chamberlin and Hoffman, 1958:52. Kevan, 1983:2968.

Metaxycheir pacifica Shelley, 1990:2311–2313, figs. 1–5.

Type specimens—Male holotype (AMNH) and 2 female paratypes (FSCA) collected by H. W. and L. L. Levi, 12 July 1951, at Graves Creek Campground, Olympic National Park, Jefferson County, Washington. One gonopod of the holotype is lost and the other is broken.

Diagnosis—With the characters of the genus, as illustrated in figures 45–49.

Description—Recently collected males from Jefferson County, Washington, conform closely to the detailed anatomical account by Shelley (1990) of the synonym, *M. pacifica*; the following supplemental observations are the only significant additions.

Facial setae: epicranial generally not detected and presumed absent; one male with one seta per side. Subantennal 1–1 and genal 2–2 on most males.

The gonocoxae are loosely joined by membrane with no trace of a sternal remnant. The coxal macrosetae are in two clusters, one above, and one below, the cannula, and vary in numbers from 2 to a cluster of 8–10.

Ecology—In Washington, *T. levii* is restricted to the wet rain forests on the western and southwestern slopes of the Olympic Mountains. I did not encounter the milliped in the wettest areas during my 1990 field trip, for example around the Hoh Visitor Center, Olympic National Park, because the vegetation is so dense that there are few areas with exposed litter. My success came in slightly drier areas, where *T. levii* was typically encountered in association with decaying deciduous logs, usually under bark. This contrasts with the situation on Vancouver Island, where I found the milliped in deciduous leaf litter in August 1989 (Shelley 1990).

Distribution—The western periphery of Vancouver Island, Canada, from the vicinities of Bamfield to China Beach Provincial Park up to 3–6 mi (5–10 km) inland, and western Clallam, and western and southern Jefferson, counties, Washington, from Bogachiel State Park to Graves Creek Campground, Olympic National Park. Canadian localities are detailed in Shelley (1990); American localities are as follows:

WASHINGTON: *Clallam Co.*, Bogachiel St. Pk., M, 6F, 23 August 1990, R. M. Shelley (NCSM). *Jefferson Co.*, Hoh rain forest, Olympic Nat. Pk., M, F, 5 May 1991, K. A. Buhlmann (VMNH); along Hoh River Rd. just outside boundry of Olympic Nat. Pk., ca. 7.4 mi (11.8 km) E jct. US hwy. 101, 3M, 4F, 24 August 1990, R. M. Shelley (NCSM); along Queets River Rd., Olympic Nat. Pk., 0.6 mi (0.9 km) inside park boundary, M, 4F, 2 juvs., 24 August 1990, R. M. Shelley (NCSM) and 4.8 mi (7.7 km) inside park boundary, M, F, 24 August 1990, R. M. Shelley (NCSM); and Graves Cr. Cpgd., Olympic Nat. Pk., M, F, 12 July 1951, H. W. & L. L. Levi (AMNH, FSCA) TYPE LOCALITY.

Remarks—Among American xystodesmids, the absence of paranota and the cylindrical, nearly julidan body form caudal to segment 4 is unique to *T. levii*. There are species in which the paranota are reduced and thus appear somewhat cylindrical, for example *S. placidus*, but no others in which these structures are entirely absent. Consequently, *T. levii* probably occupies a distinct ecological niche apart from that of the sympatric xystodesmid *Harpaphe h. haydeniana* (Wood). It is noteworthy that there is much greater variation in body form among the western, or western-related, xystodesmids than in the eastern tribes, for in addition to the cylindrical and subcylindrical *T. levii* and *S. placidus*, there are two highly convex species, *Isaphe convexa* Cook

and *Thrinaphe hargeri* Shelley (Shelley 1993*c*, *d*), and the extremely flat species of *Sigmocheir* in the Sierra Nevada Mountains of California. In contrast, although the eastern forms, representatives of the tribes Apheloriini, Rhysodesmini, Nannariini, and Pachydesmini, differ in the degree of convexity, they demonstrate similar overall body forms without nearly the somatic differences of the western species. Adaptive radiation of western xystodesmids has manifested itself in general body form to a much greater degree than has that of the eastern fauna.

Genus *Metaxycheir* Buckett and Gardner

Metaxycheir Buckett and Gardner, 1969:67. Hoffman, 1979:157. Kevan, 1983:2968.

Type species—Metaxycheir prolata Buckett and Gardner, 1969, by original designation.

Diagnosis—Paranota present and distinct on all segments; epiproct without constriction; gonocoxae narrowly segregated by narrow sternal band, latter with central lobe; telopodal elements not parallel, prefemoral process arising near midlength of prefemur, acropodite arising distad; prefemoral process narrowly blade-like, slightly bisinuate, without projections; acropodite narrowly blade-like, in form of narrow, open loop, curving through more than one vertical plane; cyphopod structure unknown.

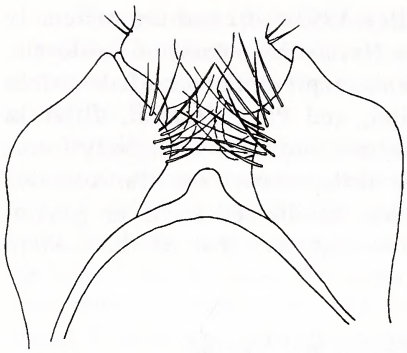
Description—A genus of small to moderate-size chonaphine xystodesminae with the following characteristics:

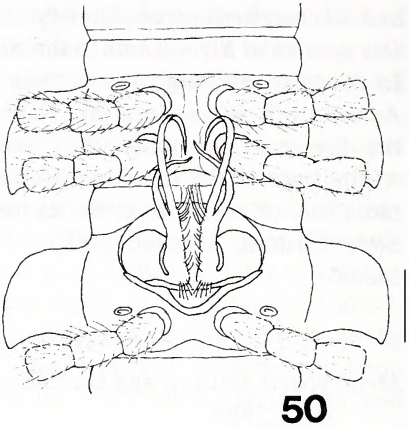
Body composed of head and 20 segments in both sexes. Head of normal appearance, smooth. Epicranial suture sharp, distinct. Antennae moderately long, with 4 conical, terminal, sensory cones and microsensilla on penultimate antennomeres. Facial setae with epicranial, interantennal, frontal, genal, clypeal, and labral series; genal setae arranged among 3 groups.

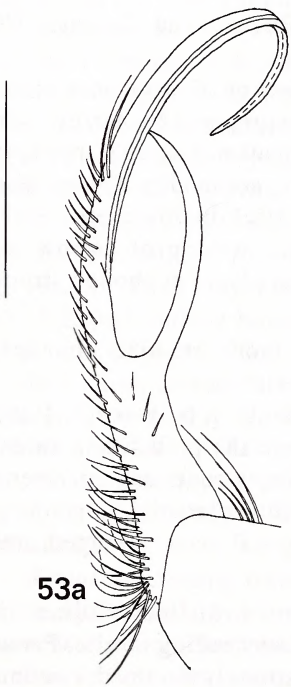
Terga smooth, polished; strictures broad, distinct. Collum large and broad, ends terminating above those of succeeding tergite. Paranota present on all tergites, broadest anteriorly, strongly declined, continuing slope of dorsum and creating appearance of vaulted body. Peritremata moderately distinct; ozopores opening sublaterad.

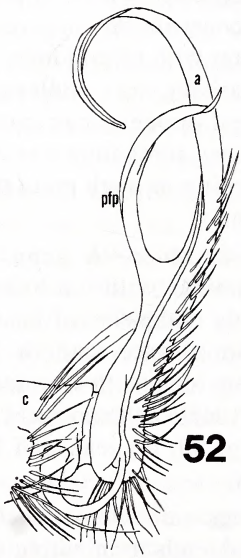
Caudal segments normal for family.

Sides of metazonites smooth, polished. Pregopnopodal sterna of males with small lobes between anterior legs of 5th segment (4th legs), moderate depression between 5th legs; 6th sternum strongly depressed between both legs. Postgonopodal sterna flat, glabrous, and









Figs. 50-53a. *Metaxycheir prolata*. 50, gonopods *in situ*, ventral view of male from Latah County, Idaho. 51, gonocoxae and sternum of male from Benewah County, Idaho, caudal view. 52, left gonopod of the same, medial view. 53a, telopodite of the same, lateral view. Abbreviations as in Figs. 2-8. Scale line for Fig. 50 = 1.00 mm; line for other Figs. = 1.20 mm for 51, 1.00 mm for 52-53.

unmodified, with only shallow transverse grooves originating between leg pairs. Coxae of legs 3-7 moderately enlarged ventrad, swelling of 3rd coxae angular on anterior surface; prefemora without trace of spines.

Gonpodal aperture generally ovoid, with caudal extension between 9th legs. Gonopods *in situ* with telopodites in parallel arrangement. Coxae with macrosetae fields in two general tufts, attached to each other by narrow sternal band, latter with central lobe. Telopodal elements not parallel; prefemur long and narrow; prefemoral process arising near midlength of prefemur, narrowly blade-like, apically acuminate, bisinuately curved, without projections. Acropodite arising distad from prefemur, long and blade-like, curving in form of narrow arc, acuminate. Prostatic groove arising in pit in prefemur, running along medial face of prefemur, angling onto lateral surface of acropodite and continuing to terminal opening.

Females unknown.

Distribution—Whitman County, Washington, to Benewah and Latah counties, Idaho.

Species—One.

Remarks—Among the three genera with long prefemoral processes, *Metaxycheir* has the simplest gonopod, consisting of an unmodified blade-like prefemoral process and a blade-like acropodite. I show them as an unresolved trichotomy in figure 72, but *Metaxycheir* may be the sister lineage to *Tubaphe* + *Montaphe*.

Metaxycheir prolata Buckett and Gardner

Figs. 50–53a

Metaxycheir prolata Buckett and Gardner, 1969:67–70, figs. 1–6. Kevan, 1983:2968.

Type specimen—Male holotype and 2 juvenile paratypes (UCD) collected by R. L. Westcott, 16 May 1965, 7 mi (11.2 km) NE Moscow, Latah County, Idaho. The vial label and citation in Buckett and Gardner (1969) incorrectly state Nez Perce County, but this site is actually in Latah County.

Diagnosis—With the characters of the genus.

Color in life—Unknown; the specimens that I collected in Whitman County, Washington, were freshly molted and lacked pigmentation.

Male from Benewah County, Idaho—The following notes on somatic features supplement the complete characterization of the holotype by Buckett and Gardner (1969); for consistency in terminology with previous accounts, gonopodal features are described in detail.

Length 20.4 mm, maximum width 3.6 mm, W/L ratio 17.6%, D/W ratio 75.0%.

Width across genal apices 2.1 mm, interantennal isthmus 0.7 mm. 6th antennomere with minute distal microsensilla. Facial setae as follows: epicranial 2-2, interantennal 1-1, frontal 2-2; genal with four groups, a central group of 4-4, one lateral to this of 1-1, one beneath antennae of 1-1, and one submarginal of 4-4; clypeal about 24-24; labral about 18-18.

Dorsum smooth, polished. Paranota well developed throughout body, broadest on anterior segments, strongly declined, angling sharply ventrad and creating appearance of strongly convex body, anterior corners rounded on all segments, caudolateral corners blunt on segments 1–4, produced slightly caudad beginning on 7 and continuing thusly to caudal end of body. Peritremata moderately distinct, moderately elevated above paranotal surface; ozopores located caudal to midlength, opening sublaterad.

Sides of metazonites smooth, polished. Gonapophyses short and broad, only slightly extending from 2nd coxae. 5th sternum with 2 short projections subtending 4th coxae, moderately depressed between 5th legs; 6th sternum strongly depressed between both leg pairs to accommodate stems of telopodites. Coxae of legs 3–7 swollen ventrad, remaining coxae unmodified, prefemora without projections.

Gonopodal aperture ovoid, extending strongly caudad between 9th legs with shelf in extension, 1.8-mm wide and 0.8-mm long at midpoint, without indentations, anterior margin flush with metazonal surface, sides elevating strongly caudad to caudolateral corner, dropping slightly on caudal extension but still well elevated above metazonal surface. Gonopods *in situ* (Fig. 50) with telopodites extending anteriad in parallel arrangement over 6th sternum, prefemoral processes curving toward each other and nearly meeting in midline. Gonopod structure as follows (Figs. 51–53a): Coxa moderate size, with sublinear field of 8–10 macrosetae, connected to opposite member by moderately sclerotized sternum, latter with medial lobe. Prefemoral process long, narrowly blade-like, arising anteriolaterad on prefemur, curving broadly mediad basally then anteriad in generally bisinuate appearance, apically acuminate. Acropodite blade-like, curving broadly anteriad then dorsad distally, sides narrowing gradually to acuminate tip, forming narrow loop.

Ecology—The Whitman County, Washington, specimens were found under thin layers of moist leaves on relatively hard substrate in a deciduous thicket beside the picnic area at Steptoe Butte. According

to the vial label, the Benewah County, Idaho, specimen was collected from under cow dung.

Distribution—Same as that of the genus, a small area of about 25.1 mi (40.2 km) east/west and 16.9 mi (27.0 km) north/south. Specimens were examined as follows:

WASHINGTON: *Whitman Co.*, Steptoe Butte, M, 2F, juv., 3 June 1993, R. M. Shelley (NCSM).

IDAHO: *Benewah Co.*, 4.0 mi (6.4 km) SE Emida, M, 16 April 1987, R. S. Zack (WSU). *Latah Co.*, 7.0 mi (11.2 km) NE Moscow, M, 2 juvs., 16 May 1965, R. L. Westcott (UCD) TYPE LOCALITY; and 3.0 mi (4.8 km) SE Harvard, Laird Park, M, 1 May 1971, W. A. Turner (WSU).

Remarks—No females have been collected of *M. prolata*, so the cyphopod structure is unknown.

This species has a much broader, less acicular and more blade-like, acropodite than do the other chonaphine species with long prefemoral processes. However, the aperture and sternum conform to those of the species of *Chonaphe*, *Montaphe*, and *Semionellus*.

Selenocheir, new genus

Type species—*Selenocheir sinuata*, new species.

Diagnosis—Paranota present and variably distinct on all segments; epiproct without constriction; gonocoxae moderately separated, attached by membrane only, without trace of sclerotized band; telopodal elements not parallel, prefemoral process arising proximad on prefemur, acropodite arising distad; prefemoral process short, less than half as long as acropodite, generally sublinear, apically variable; acropodite variably blade-like to subacicular, subtending broad, variable arc, curving through single vertical plane; cyphopod valves without lobes, extensions, or cavities; receptacle very large, partly enveloping valves.

Description—A genus of moderately large chonaphine Xystodesminae with the following characteristics.

Body composed of head and 20 segments in both sexes, essentially parallel sided, tapering at both ends.

Head of normal appearance, smooth, polished. Epicranial suture distinct, terminating in interantennal region. Antennae relatively long and broad, becoming progressively more hirsute distad, with 4 conical sensory cones and microsensilla on outer distal margin of penultimate antennomere. Genae not margined laterally, with shallow central impressions, ends narrowly rounded and extending just beyond adjacent cranial margins. Facial setae with epicranial, genal, clypeal, and labral series present, with or without interantennal, subantennal, and frontal series.

Terga smooth, polished. Collum relatively broad, ends terminating below or at same level as those of following tergite. Paranota well developed, broadest on anteriormost segments, moderately declined, continuing slope of dorsum, anterior corners with variably small denticles on segments 2–4, rounded thereafter, caudolateral corners variable, either angular, blunt, or rounded. Peritremata broad, moderately distinct, moderately elevated above paranotal surface; ozopores located caudal to midlength, opening laterad to sublaterad. Caudal segments normal for family.

Sides of metazonites with irregularly serrate to jagged ridges subtending leg coxae in anteior half of body. Strictures distinct. Gonapophyses moderately long, extending moderately from 2nd coxae. Pregonopodal sterna glabrous; 4th sternum unmodified; 5th sternum with variable low knobs or elevated areas between 4th legs, flat, depressed, or with low, elevated areas between 5th; 6th sternum either depressed between both legs or with widely separated lobes between anterior pair. Postgonopodal sterna glabrous, unmodified, with at most only shallow transverse grooves, caudal margins smooth and gently curved. Coxae without projections; prefemora with variably short, indistinct ventrodistal spines in caudal half of body; tarsal claws gently curved. Hypoproct broadly rounded, usually slightly extended in midline; paraprocts with margins strongly thickened.

Gonopodal aperture generally broadly ovoid, with at most only very slight caudal extension of caudal margin, without anteriolateral indentations, anterior margin flush with metazonal surface, sides elevating caudad and continuing onto caudal margin, latter flared. Gonopods *in situ* with telopodites directed either anteriad or anteromediad from aperture, angling toward each other, lying parallel or crossing in midline, extending forward over anterior margin of aperture and 6th sternum. Coxae moderate-size, with 2 macrosetae above cannula and variably dense cluster below, connected by membrane only, without trace of sclerotized sternal band. Telopodal elements not parallel; prefemur relatively short to moderately long; prefemoral process short, arising proximad on anterior side, latter less than half as long as acropodite, generally sublinear basally, with or without slight curve or bend at midlength, apically broad or narrow, variably divided or simple. Acropodite arising distad from prefemur, either smoothly or demarcated by constriction, directed anteriad or anteromediad, relatively long, blade-like basally, narrowing distad and in some cases becoming subacicular, curving downward or dorsad distally and subtending variable arch, with or without variably sinuate to uncinate apical bends or curves, apically acuminate. Prostatic groove arising in pit in prefemur, running

along medial surface of latter and crossing to lateral side at base of acropodite, crossing back to inner surface, or continuing along outer, to terminal opening.

Cyphopodal aperture broad, encircling 2nd legs, sides and caudal margin elevated above metazonal surface, latter rising to peak in midline. Cyphopods *in situ* with valves oriented transversely in aperture, common surface visible in opening. Valves variable in size, subequal or anterior valve slightly larger, without distinct lobes or cavities, situated nearly entirely on top of (ventral to) receptacle. Latter large, alate, cupped around valves, more so on anterior side, with long hairs arising from ventral margin. Operculum small to large, located laterad to valves, with numerous long hairs.

Distribution—From Curry and Jackson counties, in southwestern Oregon, to Mendocino and El Dorado counties, California, in the northern Coast Range, the northern Sacramento Valley, and the Sierra Nevada foothills, an area of about 176 mi (282 km) east/west and 273 mi (437 km) north/south.

Species—Three are currently recognized.

Remarks—The Chonaphini is the best placement for this genus, as the only other option is a new tribe. It displays narrowly blade-like to acicular acropodites that are similar to those of *Tubaphe* and *Metaxycheir*, and shares the absence of a sternum with *Tubaphe*. The short prefemoral process is plesiomorphic, and *Selenocheir* tends to bridge the anatomical gap between the Chonaphini and Harpaphini in having a larger coxa in relation to the overall bulk of the telopodite, and in the anteromedially directed acropodites, particularly in *S. directa*, reminiscent of the condition in *Isaphe* (Shelley 1993*d*).

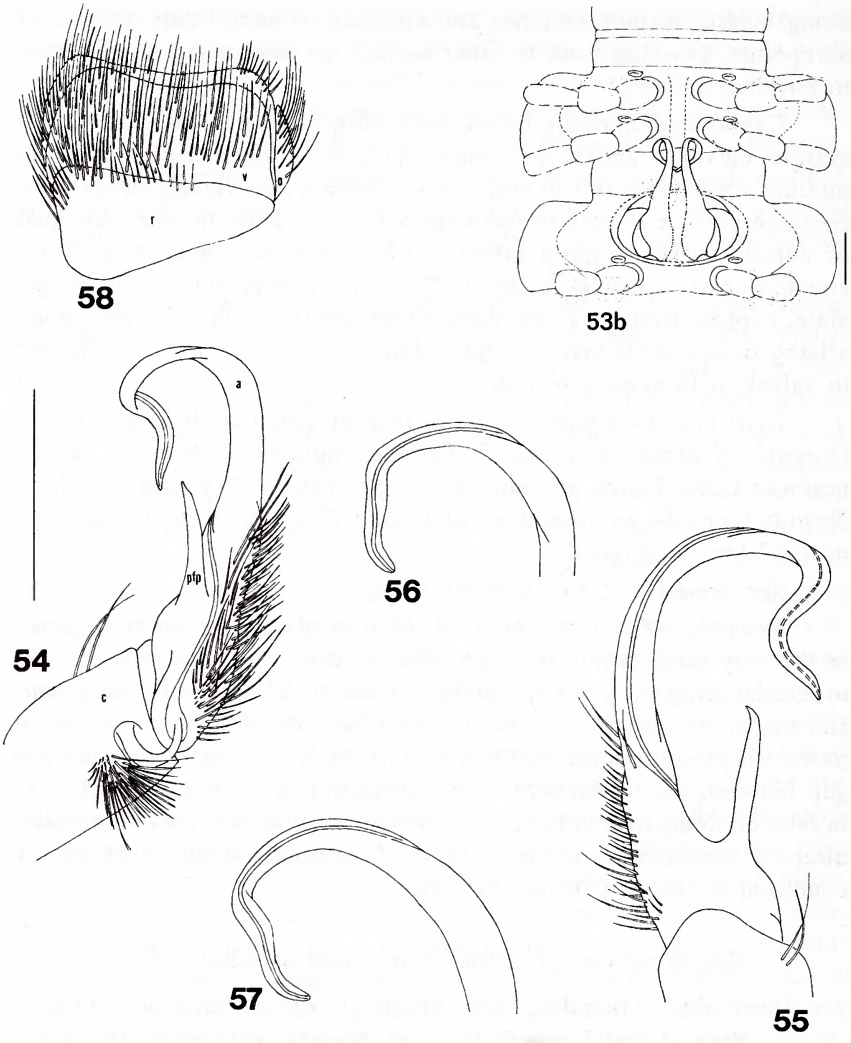
Key to Species of *Selenocheir*, based on adult males.

1. Acropodite subtending very broad, poorly defined arc, without distinct distal curvature (Figs. 60–61); Tehama to Humboldt and Mendocino counties, California ..... *arcuata*, new species

   Acropodite curving definitely downwards or dorsad distally, with relatively distinct distal curve or bend 2

2. Distal part of acropodite, distal to distal curve/bend, variably sinusoid (Figs. 54–57); Shasta to Mendocino and El Dorado counties, California ..... *sinuata*, new species

   Distal part of acropodite without trace of sinusoid pattern (Figs. 65–66); Curry and Jackson counties, Oregon, to Del Norte County, California ..... *directa*, new species



Figs. 53b-58. *Selenocheir sinuata*. 53b, gonopods *in situ*, ventral view of male from El Dorado County, California. 54, left gonopod of holotype, medial view. 55, telopodite of the same, lateral view. 56, distal extremity of acropodite of left gonopod of male from Humboldt County, California, medial view. 57, distal extremity of acropodite of left gonopod of male from W of Burney, Shasta County, California, medial view. 58, left cyphopod of female paratype, caudal view. Abbreviations as in Figures 2-8. Scale line for Figure 53b = 1.00 mm; line for other Figures = 1.33 mm for 54-55, 1.14 mm for 56-57, 1.00 mm for 58.

Selenocheir sinuata, new species

Figs. 53b–58

Hybaphe tersa (nec Cook, 1904): Causey, 1954*a*:222, fig. 1; 1955:91. Chamberlin and Hoffman, 1958 (in part):36. Buckett, 1964:8–9.

Type specimens—Male holotype and 3 male, 7 female, and 3 juvenile paratypes (UCD) collected by J. S. Buckett and M. R. Gardner, 20 December 1966, 2 mi (3.2 km) southwest of Dales, Tehama County, California. One male and one female paratypes deposited at NCSM.

Diagnosis—Acropodite directed generally anteriad from coxa, distal curvature sharp, well defined, distal part variably sinusoid, blade-like throughout length.

Color in Life—Paranota variably red to orange, metaterga black with concolorous red to orange bands along caudal margins or middorsal semilunar blotches.

Holotype—Length 27.6 mm, maximum width 9.5 mm, W/L ratio 34.4%, D/W ratio 33.7%.

Epicranial suture strong, distinct, terminating in interantennal region. Width across genal apices 2.7 mm, interantennal isthmus 1.2 mm. Antennae relatively long and broad, reaching back to midlength of 4th tergite; relative lengths of antennomeres 2>3>6>4>5>1>7; 6th antennomere with microsensilla on outer distal margin. Genae with shallow central impressions. Facial setae as follows: epicranial 2–2, interantennal, subantennal, and frontal not detected and presumed absent, genal 1–1, clypeal about 8–8, labral about 12–12.

Collum broad, ends terminating slightly below those of succeeding tergite. Tergites smooth, polished. Paranota well developed throughout body, broadest on anterior segments, becoming slightly narrower caudad, moderately depressed, continuing slope of dorsum, anterior corners with small but distinct denticle on segments 2–4, broadly rounded on remaining segments, caudolateral corners angular on 2–3, blunt on 4–5, rounded on remaining tergites, becoming progressively angled caudad in caudal half of body. Peritremata moderately distinct, moderately elevated above paranotal surfaces; ozopores located caudal to midlength, opening sublaterad.

Sides of metazonites granular, with distinct, irregularly serrate to jagged ridges subtending coxae through segment 10, becoming progressively indistinct thereafter. Gonapophyses moderately long, apically rounded. Pregonopodal sterna glabrous; 5th sternum with two low, paramedian knobs between 4th legs, much shorter than widths of adjacent coxae, and lower, flattened elevated areas between 5th legs; 6th sternum strongly depressed between both leg pairs to accommodate

curvatures of telopodites. Postgonopodal sterna glabrous, flat, and unmodified, with at most only shallow transverse grooves between leg pairs, caudal margins gently curved. Coxae without projections; prefemora of legs on segments 9-18 with ventrodistal spines, longer and more distinct on segments 11-15; tarsal claws gently curved. Hypoproct broadly rounded, slightly extended in midline; paraprocts with margins strongly thicked.

Gonopodal aperture ovid, without indentations, 1.4-mm wide and 0.7-mm long at midpoint, anterior margin flush with metazonal surface, sides elevating caudad and continuing onto caudal margin, latter flared slightly but not extending caudad. Gonopods *in situ* (Fig. 53b) with acropodites extending forward in parallel arrangement, overhanging anterior margin of aperture, apices curling laterad then mediad. Gonopod structure as follows (Figs. 54–55): Coxae moderate-size, connected by membrane only, without trace of sclerotized sternal remnant; with 2 macrosetae above cannula and dense cluster of a dozen or so setae on protuberance below latter. Prefemur moderately long and broad, with short prefemoral process arising near midlength on anterior side, latter extending to just beyond level of tip of acropodite, broadest basally, sides narrowing and tapering to subacuminate tip on lateral margin, directed toward midpoint of arc of acropodite. Latter arising from prefemur at narrow constriction, relatively long, blade-like for most of length, tapering smoothly and continuously, more so distad, to subacuminate tip, in form of broad open arch, flattened at highest point, curving broadly anteriad at 1/3 length and bent more strongly dorsad at 2/3 length, distal part curving in markedly bisinuate fashion. Prostatic groove arising in pit in prefemur, running along medial surface of latter and crossing to lateral side at base of acropodite returning to inner surface at peak of arch and continuing to terminal opening.

Male Paratypes—In two individuals the acropodites cross *in situ* at the midline instead of lying parallel, and in one male the prefemoral process is shorter in relation to the acropodite.

Female paratype—Length 29.0 mm, maximum width 4.5 mm, W/L ratio 15.5%, D/W ratio 82.2%. Agreeing essentially with males excepting the presence of interantennal, subantennal, and frontal setae, 1-1 each, and paranota more strongly depressed, imparting more vaulted appearance to body. Cyphopod aperture encircling 2nd legs, sides and caudal margin flush with metazonal surface, elevated only midline. Cyphopods *in situ* lying transversely in aperture, common surface visible in opening. Valves (Fig. 58) relatively small, unequal, anterior valve larger, situated nearly entirely on top of receptacle, slightly

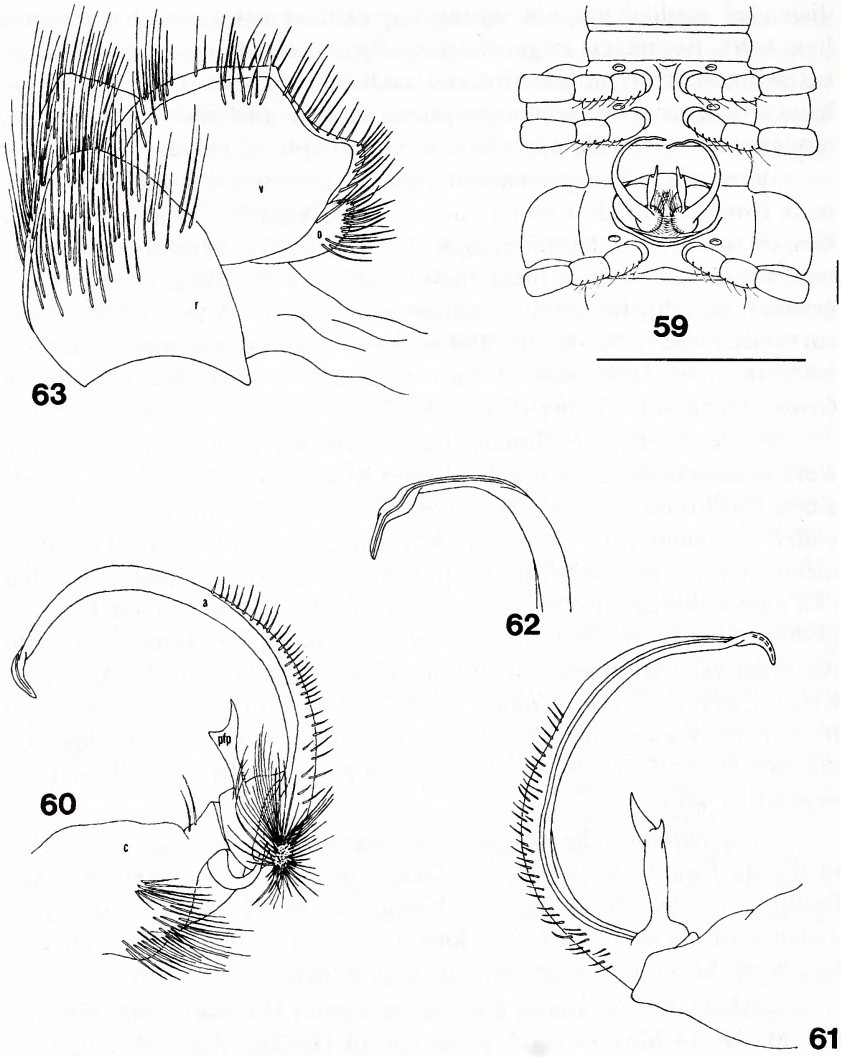
distended mediad but not subtending distinct cavity, with numerous long hairs. Receptacle large, alate, nearly completely enveloping valves, extending halfway up anterior and caudal valvular surfaces, with long hairs arising from ventral margin primarily from medial side. Operculum, moderate-size, closely appressed to lateral side of valves.

Variation—The prefemoral process is noticeably shorter in the male from El Dorado County and rises to a peak in the midline rather than on the outer or lateral margin. The acropodite therefore terminates well above the latter in these individuals, and the distal bend is more gradual, thereby imparting a somewhat sigmoid pattern to the distal curvature rather than sinuate. The sinuate condition is noticeably diminished in males from west of Burney, Shasta County, and Richardson Grove, Humboldt County (Figs. 56–57).

Ecology—The specimens that I collected in El Dorado County were encountered under wet hardwood litter beside a stream in a cove along California highway 49. Those from Shasta County were found under deciduous litter, mostly poison oak, on a bank above the Sacramento River. The male from Butte County was found under a pine log in a pine/fir association near a creek. According to Buckett and Gardner (1968), *S. sinuata*, cited as *Hybaphe* sp., occurs in association with luxuriant vegetation near the bottom of the south wall of the American River Canyon, Placer County, and is thus ecologically segregated from *Wamokia discordis* Buckett and Gardner, which occurs high on the canyon wall, where the slope is steeper, the soil leached, and the vegetation thin.

Distribution—The northern periphery of the Sacramento Valley in Shasta County to the Pacific Ocean in Humboldt County and the foothills of the Sierra Nevada Mountains in El Dorado County, a distance of about 147 mi (236 km) north/south and 154 mi (246 km) east/west. Specimens were examined as follows:

CALIFORNIA: *Shasta Co.*, W of Burney, Moose Camp. Hatchet Cr., M, 3F, 14 May 1966, A. A. Grigarick (UCD); along McCloud R., exact location unknown, 2M, F, 4 May 1929, E. C. Van Dyke (UCD); Project City N of Redding, M, 10 December 1982, B. Miller (SDMNH); Redding, along Sacramento R. trail, 2M, 3F, juv., 28 April 1991, R. M. Shelley (NCSM); 21 mi (33.6 km) W Redding, F, 21 December 1966, J. S. Buckett, M. R. Gardner (UCD); and Inwood, 4 mi (6.4 km) NW Shingletown, F, 20 December 1966, J. S. Buckett, M. R. Gardner (UCD). *Humboldt Co.*, Richardson Grove St. Pk., M, 15 May 1966, H. Wilson (UCD). *Tehama Co.*, 2 mi (3.2 km) S Dales, off CA hwy. 36, 5M, 8F, 3 juvs., 20 December 1966, J. S. Buckett, M. R.



Figs. 59–63. *Selenocheir arcuata*. 59, gonopods *in situ*, ventral view of paratype. 60, left gonopod of holotype, medial view. 61, the same, lateral view. 62, distal extremity of acropodite of male from 2 mi (3.2 km) N Pashkenta, Tehama County, California, medial view. 63, left cyphopod of female paratype, caudal view. Abbreviations as in Figs. 2-8. Scale line for Fig. 59 = 1.00 mm; line for other Figs. = 1.60 mm for 60-61, 1.33 mm for 62, 1.00 mm for 63.

Gardner (UCD) TYPE LOCALITY; and 22 mi (35.2 km) W Red Bluff, 2M, 3F, 22 December 1966, J. S. Buckett, M. R. Gardner (UCD). *Butte Co.*, Forest Ranch, M, 27 April 1991, R. M. Shelley (NCSM); and Chico, 4M, 3F, 7 May 1968, T. Komo, R. Wilkey, W. Wiard (UCD). *Placer Co.*, 1 mi (1.6 km) E Auburn, 4M, 28 January 1965, M. R., R. C., J. L., B. W., and K. B. Gardner (UCD). *El Dorado Co.*, cove along CA hwy. 49, 1 mi (1.6 km) S Placer Co. line, 4M, juv., 27 April 1991, R. M. Shelley (NCSM); and nr. confluence of North & Middle Forks, American R., M, 26 March 1965, J. S. Buckett, M. R. Gardner (UCD).

The following literature records of *Hybaphe tersa* from Shasta County, in close proximity to each other, are believed to refer to *S. sinuata* and are indicated by the open star in Figure 68. They are the basis for Chamberlin and Hoffman's citation (1958) of Shasta County for *H. tersa* and for Hoffman's citation (1979) of California for *Hybaphe*. The Placer County record is of "an undescribed species of *Hybaphe*" (Buckett and Gardner 1968).

CALIFORNIA: *Shasta Co.*, Mt. Brock (Causey 1954*a*); Low Pass Cr. (Causey 1954*a*, 1955, Buckett 1964); and Madison Cr. (Causey 1955, Buckett 1964). *Placer Co.*, American River Canyon near Auburn (Buckett and Gardner 1968).

Remarks—Buckett and Gardner (1968) also recognized that this species occurs in Shasta and Tehama counties.

Selenocheir arcuata, new species

Figs. 59–63

Type specimens—Male holotype and 9 male and 2 female paratypes (UCD) collected by C. Smith, J. Clover, and F. Ennik, 15 May 1972, at Black Rock Camp along Mill Creek, 18.8 mi (30.0 km) northeast of Red Bluff, Tehama County, California. One male paratype deposited in NCSM.

Diagnosis—Acropodite blade-like basally, becoming subacicular apically, directed anteromediad, subtending broad, poorly defined arc, distal curvature broad, indistinct, distal extremity either uncinate or with short bisinuate section.

Color in life—Unknown.

Holotype—Length 30.8 mm, maximum width 4.8 mm, W/L ratio 15.6%, D/W ratio 68.8%.

Somatic features agreeing with those of *S. sinuata*, with following exceptions:

Width across genal apices 3.2 mm; interantennal isthmus 0.9 mm. Relative lengths of antennomeres 2>3>6>4>5>1>7. Genae with

distinct central impressions. Facial setae as follows: epicranial 2–2, interantennal and subantennal not detected and presumed absent, frontal 1–1, genal 2–2, clypeal about 12–12, labral about 20–20.

Caudolateral corners of paranota angular on segments 2–3, blunt on 4–8, rounded on remaining tergites, becoming progressively angled caudad in caudal half of body.

Sides of metazonites with irregularly serrate ridges subtending coxae through segment 7, becoming progressively indistinct thereafter. 5th sternum with very low, indistinct lobes between 4th legs, flat and unmodified between 5th; 6th sternum with two distinct, widely separated subtriangular lobes subtending anterior (6th) coxae, depressed centrally to accommodate telopodites. Prefemoral spines present on legs on segments 11–18, short and indistinct.

Gonopodal aperture broadly rounded, without indentations, 1.2-mm wide and 0.9-mm long at midpoint, anterior margin flush with metazonal surface, sides elevating strongly caudad and continuing onto caudal margin, latter flared slightly and extending slightly caudad in midline. Gonopods *in situ* (Fig. 59, of paratype) with acropodites leaning laterad then curving broadly anteromediad, tips nearly overlapping, extending well beyond anterior margin of aperture and over 6th sternum. Gonopod structure as follows (Figs. 60-61): Coxae moderate-size, connected by membrane only, with 2 macrosetae above cannula, dense cluster of innumerable setae below cannula, and 4–5 setae above latter cluster. Prefemur moderately long and broad, with short prefemoral process arising anteriad, latter narrow basally, extending distad a short distance, then expanding to shallowly divided tip, medial side longer and more acute. Acropodite arising imperceptibly from prefemur, without constriction, long and narrowly blade-like for most of length, becoming subacicular distad, in form of very broad, open arch, gently curved at highest point, curving broadly anteriad basally and continuing at essentially same curvature to just before tip, where it bends suddenly in uncinate fashion, narrowing thereafter to subacuminate tip. Prostatic groove arising in pit in prefemur, running along medial side of latter and curving onto lateral side of acropodite, angling back onto medial surface at level of base of uncinate curve and continuing to terminal opening.

Male paratypes—The male paratypes agree closely with the holotype except for the prefemoral process, which is slightly different on nearly every individual. Its length and the apical division vary, as the terminations are more unequal than in the holotype. In one paratype,

the lateral termination is absent, and the medial one arises from an otherwise flat surface.

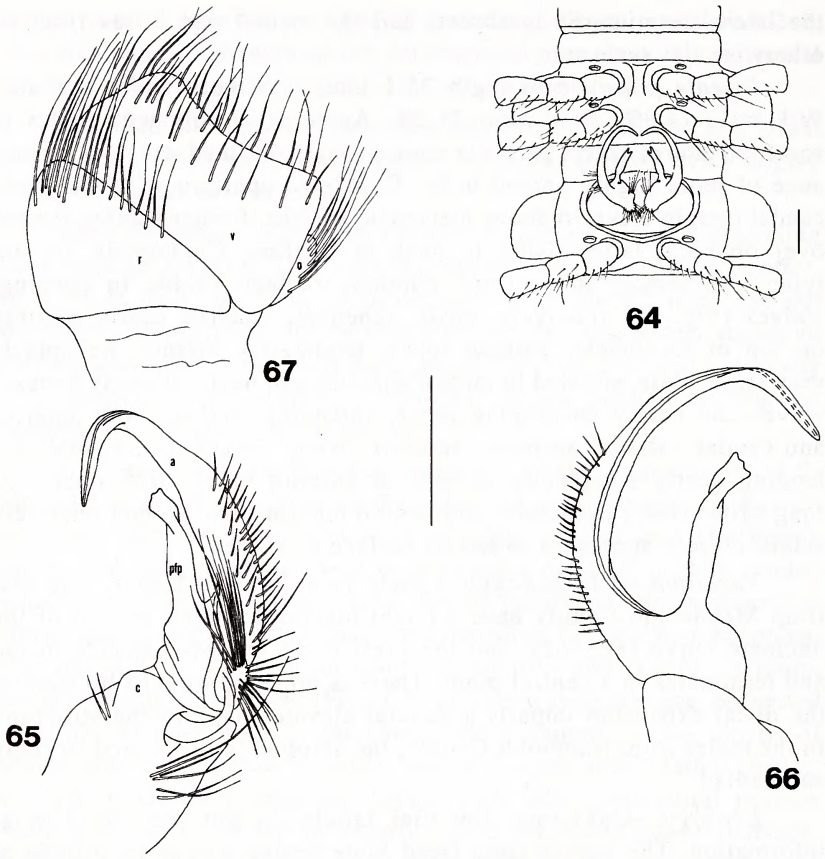
Female paratype—Length 35.1 mm, maximum width 5.2 mm, W/L ratio 14.8%, D/W ratio 71.2%. Agreeing closely with males in somatic features except paranota more strongly declined, creating appearance of more highly arched body. Cyphopod aperture with sides and caudal margin elevated above metazonal surface, former leaning inward over opening, latter rising to peak in midline. Cyphopods *in situ* lying transversely in aperture, common surface visible in opening. Valves (Fig. 63) relatively small, subequal, situated nearly entirely on top of receptacle, without lobes, moderately hirsute. Receptacle very large, alate, situated to medial side but still nearly directly beneath valves and nearly enveloping latter, extending well up both anterior and caudal valvular surfaces, anterior "wing" larger than caudal, extending nearly completely up side of anterior valve, with numerous long hairs arising from sides and ventral margins. Operculum relatively small, closely appressed to lateral surface of valves.

Variation—The non-typical male from Tehama County and that from Mendocino County have a slight bisinuate stretch instead of the uncinate curve (Fig. 62), and the prefemoral process expands distad and terminates in a central point. There is no suggestion of bifuration; the distal expansion imparts a general clavate shape to the structure. In the males from Humboldt County, the acropodite is directed strongly submediad.

Ecology—Unknown; the vial labels do not provide habitat information. The sample from Dead Mule Spring was at an altitude of about 5,150 ft; those from Lake County were collected at 3,910 ft. by ultraviolet light.

Distribution—The northern Sacramento Valley and Coast Range of California, an area of about 84 mi (134 km) east/west and 119 mi (190 km) north/south. Specimens were examined as follows:

CALIFORNIA: *Tehama Co.*, Black Rock Camp along Mill Cr., 18.8 mi (30 km) NE Red Bluff, 10M, 2F, 15 May 1972, C. Smith, J. Clover, F. Ennik (UCD) TYPE LOCALITY; and Dead Mule Spring, along unnamed rd., 2 mi (3.2 km) N Paskenta/Covelo rd., M, F, 29 August 1972, H. B. Leech (CAS). *Mendocino Co.*, 6 mi (7.6 km) N Potter Valley, M, 28 January 1967, J. S. Buckett, M. R. Gardner (UCD). *Humboldt Co.*, 5 mi (8.0 km) N Willow Creek (town), Tish Tang Rec. area, 5M, 21 February 1976, and 2M, 3F, 20 December 1979, A. K. Johnson (NCSM). *Lake Co.*, nr. clear Lake, N side Bartlett



Figs. 64-67. *Selenocheir directa*. 64, gonopods *in situ*, ventral view of paratype. 65, left gonopod of holotype, medial view. 66, telopodite of the same, lateral view. 67, left cyphopod of female paratype, caudal view. Abbreviations as in Figs. 2-8. Scale line for Fig. 64 = 1.00 mm; line for other Figs. = 1.00 mm for 65-66, 0.80 mm for 67.

Mtn. Summit, Mendocino Nat. For., M, F, 28 April 1969, F. Emmik, M. Knudson (UCD).

Selenocheir directa, new species

Figs. 64–67

Type specimens—Male holotype and 20 male, 10 female, and 3 juvenile paratypes (NMNH) collected by A. K. Johnson, 22 December 1977, at Patrick Creek Campground, along US highway 199, 7 mi

(11.2 km) northeast of Gasquet, Del Norte County, California. Seven male and 4 female paratypes deposited in NCSM.

Diagnosis—Acropodite directed strongly submediad, blade-like throughout length, narrowing slightly distad, curving distinctly downward or dorsad distally, without trace of sinusoid curvature.

Color in life—Unknown.

Holotype—Length 24.6 mm, maximum width 3.9 mm, W/L ratio 15.9%, D/W ratio 76.1%.

Somatic features agreeing with those of *S. sinuata*, with following exceptions:

Width across genal apices 2.8 mm; interantennal isthmus 0.9 mm. Relative lengths of antennomeres 2>3>6>4>5>1>7. Facial setae as follows: epicranial 2–2, interantennal 1–1, subantennal 1–1, frontal 1–1, genal 2–2, clypeal about 13–13, labral about 18–18.

Collum terminating at same level as succeeding tergite. Caudolateral corners of paranota angular on segments 2–3, blunt on 4–6, rounded on remaining tergites, becoming progressively angled caudad in caudal half of body.

Sides of metazonites with irregularly serrate ridges subtending coxae through segment 9, becoming progressively indistinct thereafter. 5th sternum with low, rounded elevated areas between 4th legs, slightly depressed between 5th; 6th sternum depressed between both legs to accommodate telopodites. Prefemoral spines present on legs of segments 13–18, short and indistinct.

Gonopodal aperture broadly rounded, without indentations, 1.2-mm wide and 0.6-mm long at midpoint, anterior margin flush with metazonal surface, sides elevating slightly caudad and continuing onto caudal margin, latter extended slightly caudad. Gonopods *in situ* (Fig. 64, of paratype) with acropodites curving broadly submediad, tips nearly overlapping, extending well beyond anterior margin of aperture and overhanging 6th sternum. Gonopod structure as follows (Figs. 65–66): Coxae moderately-large, nearly equal to telopodite in overall bulk, connected by membrane only, with 2 macrosetae above cannula and moderate cluster of setae below. Prefemur relatively short and broad, with moderately long prefemoral process arising anteriad, about half as long as acropodite, broad basally, bent slightly dorsad and twisted at 2/3 length, broad apically. Acropodite arising at slight constriction of prefemur, moderately broad basally, directed submediad, configuration a moderately broad arch, curving broadly at midlength, sides narrowing smoothly and continuously to subacuminate tip. Prostatic groove arising in pit in prefemur, running along medial side of latter

and curving onto lateral margin of acropodite, continuing to terminal opening.

Male paratypes—Except for minor variation in the length, degree of bend, and broadness of the tip, the male paratypes agree with the holotype.

Female paratype—Length, 28.1 mm, maximum width 5.1 mm, W/L ratio 18.1%, D/W ratio 74.5%. Agreeing essentially with males in somatic features except paranota more strongly declined creating appearance of more highly arched body. Cyphopodal aperture very broad, sides and caudal margin elevated above metazonal surface, latter rising to peak in midline. Cyphopods *in situ* lying transversely in aperture, common surface visible in opening. Valves (Fig. 67) moderately large, subequal, without distinct lobes, moderately hirsute, situated nearly entirely on receptacle, nearly completely enveloped by latter. Receptacle large, alate, situated to medial side but nearly directly beneath (dorsal to) valves, extending nearly completely up anterior side of latter, caudal "wing" shorter, with numerous long hairs arising from ventral margin. Operculum relatively large, closely appressed to lateral sides of valves.

Variation—Aside from differences in the length and apical configuration of the prefemoral process, the nontypical males agree closely with the holotype.

Ecology—Unknown.

Distribution—The adjacent corners of southwestern Oregon and northwestern California, an area of about 78 mi (125 km) east/west and 59 mi (94 km) north/south. Specimens were examined as follows:

OREGON: *Curry Co.*, 1 mi (1.6 km) N Gold Beach, on opposite bank of Rogue R., 2M, 30 January 1967, A. Jung (UCD). *Jackson Co.*, Shady Cove, M, 28 March 1972, J. Schuh (FSCA); 10 mi (16 km) E, 6 mi (9.6 km) N Gold Hill, along OR Hwy. 234, M, 22 January 1972, E. M. Benedict (WAS); and 10 mi (16 km) NW Central Point, along OR hwy. 234, M, 22 January 1972, E. M. Benedict (WAS).

CALIFORNIA: *Del Norte Co.*, 7 mi (11.2 km) NE Gasquet, Patrick Cr. Cpgd. along US hwy. 199, 28M, 14F, 3 juvs., 22 December 1977, and 3M, 3F, 21 December 1979, A. K. Johnson (NMNH, NCSM) TYPE LOCALITY.

Remarks—Selenocheir directa bridges the anatomical gaps between the Chonaphini and the Harpaphini, and future workers may conclude that this necessitates synonymizing the tribes. The coxa in *S. directa* is larger in comparison to the telopodal elements than in any of the congeners or any other chonaphines, and the acropodite is directed

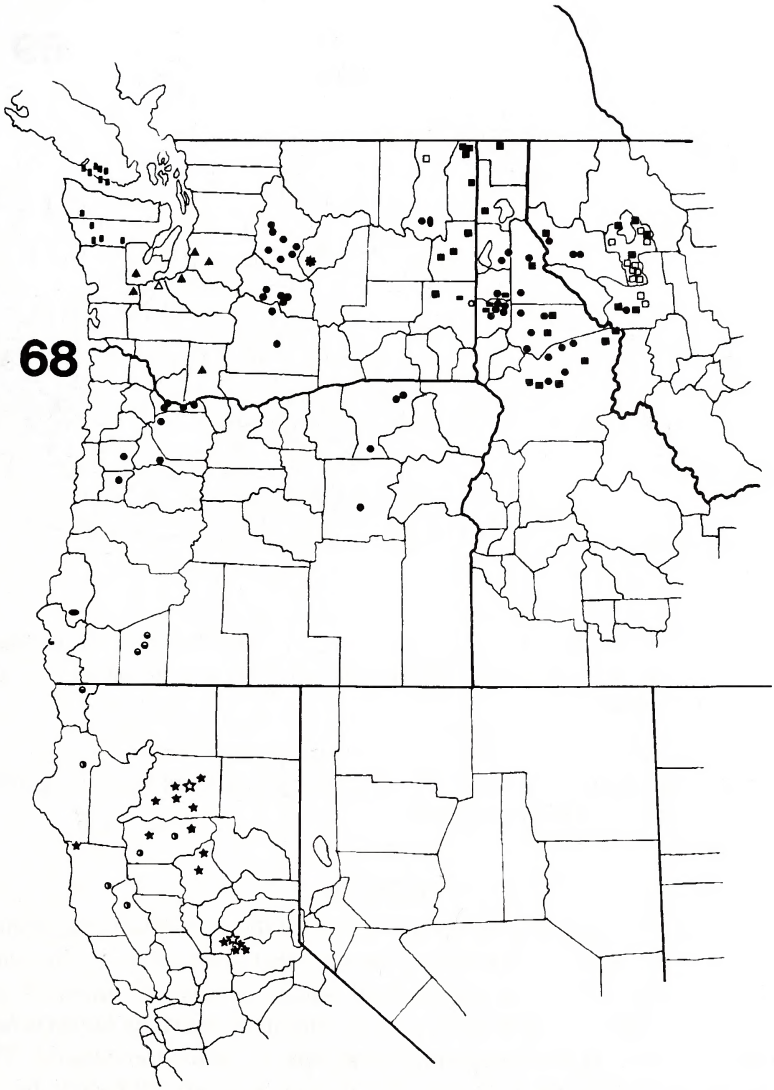


Fig. 68. Distributions of chonaphine genera and species in western North America. dots, *Chonaphe armata*; triangles, *C. remissa*; horizontal oval (southwestern Oregon), *C. evexa*; vertical oval (northeastern Washington), *C. schizoterminalis*; squares, *Montaphe elrodi*; asterisk (central Washington), *M. paraphoena*; vertical rectangles, *T. levii*; horizontal rectangles (Idaho), *Metaxycheir prolata*; stars, *Selenocheir sinuata*; vertical half-shaded dots, *S. arcuata*; horizontal half-shaded dots, *S. directa*. Open symbols denote literature records deemed reliable; the larger, open star signifies three literature sites clustered in the same area.

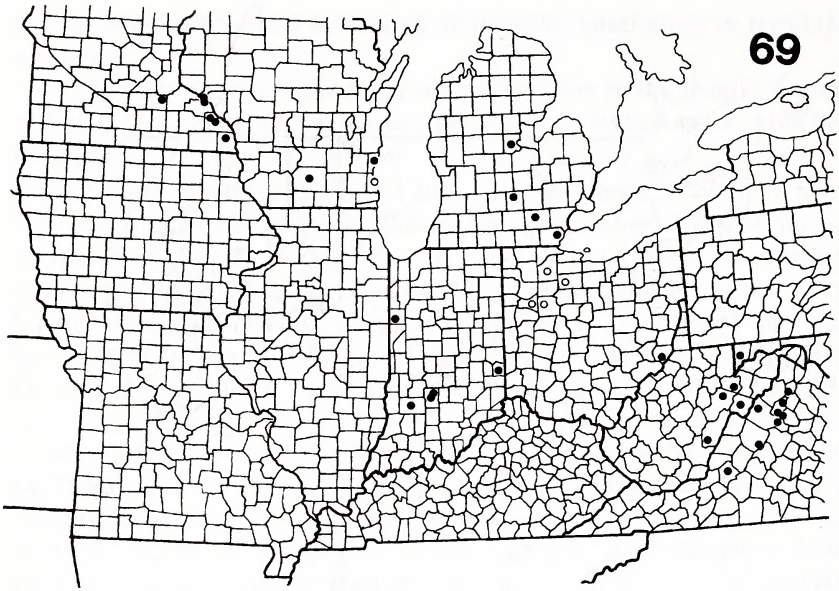


Fig. 69. Distributions of the *Chonaphini*, *Semionellus*, and *S. placidus* in the eastern United States. Open symbols denote literature records considered accurate.

strongly submediad on the coxa. These traits approximate those diagnostic for the Harpaphini (Shelley 1993*d*).

DISTRIBUTION

Species and genera—As shown in Figure 70, the western chonaphine species occupy mutually exclusive ranges, segregated from each other, aside from the region in and around Idaho, where *C. armata* and *Montaphe elrodi* overlap broadly; the former also overlaps *Metaxycheir prolata*, and the latter completely envelops *C. schizoterminalis*. The sympatry in California between *S. sinuata* and *arcuata* may be an artifact because so few records are available from the Coast Range in Lake, Mendocino, Trinity, and Humboldt counties. The northernmost, Humboldt County, population of *S. arcuata* may be allopatric and detached from the rest of the species, which occurs generally to the south-southwest of *S. sinuata*. I have assumed that these populations connect, which accounts for the range overlap with *S. sinuata*; if they do not overlap, *S. arcuata* and *sinuata* are parapatric. Both *S. sinuata* and *Montaphe elrodi* show southward projecting fingers from their

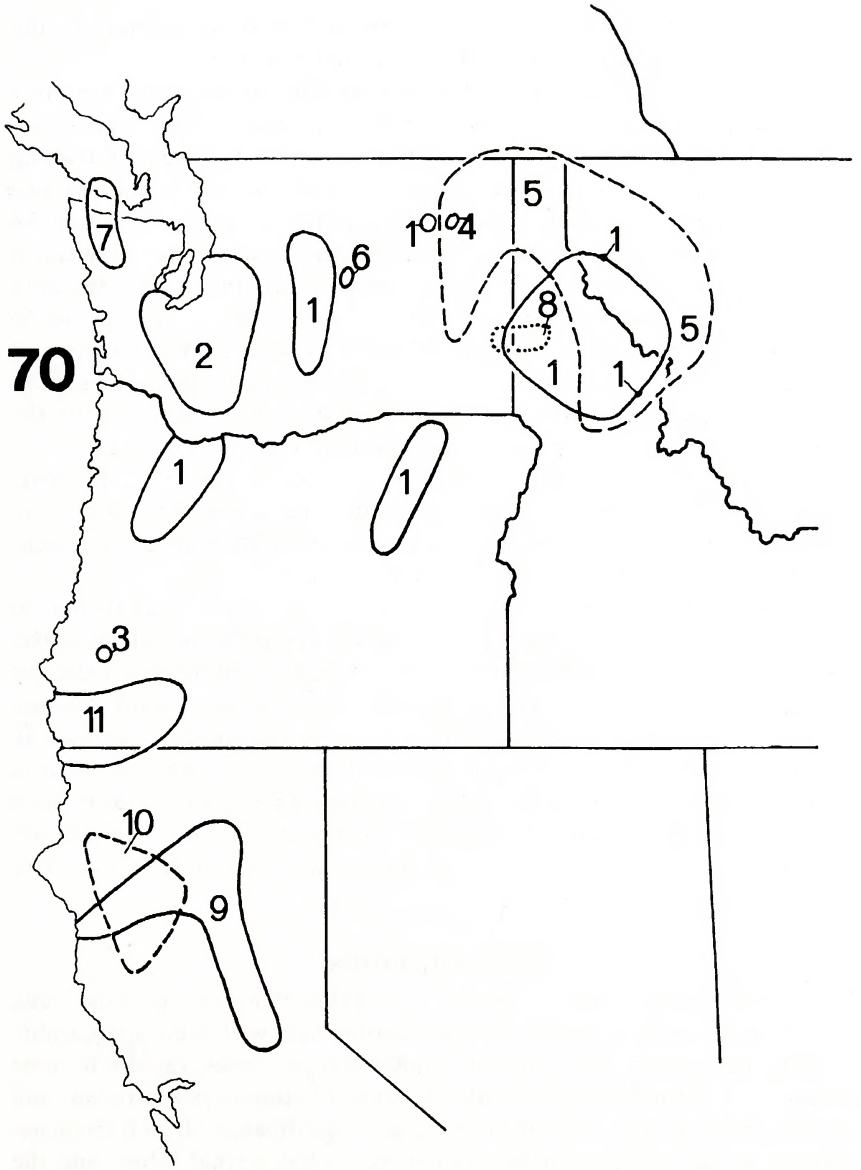


Fig. 70. Comparative distributions of chonaphine species in western North America. **1**, *C. armata*; **2**, *C. remissa*; **3**, *C. evexa*; **4** *C. schizoterminalis*; **5**, *Montaphe elrodi*; **6**, *M. paraphoena*; **7**, *T. levii*; **8**, *Metaxycheir prolata*; **9**, *S. sinuata*; **10**, *S. arcuata;* **11**, *S. directa.*

main ranges; the former is thus the southernmost chonaphine in the West, and the latter, the northern- and eastern-most.

Chonaphe armata and *S. placidus* are the species with the most interesting distributions; they occur in five and four areas, respectively (Figs. 68, 69). In both cases, an ancestral range has fragmented, leaving allopatric populations that have undergone little anatomical divergence and are hence conspecific. Additionally, the distances between the five populations of *C. armata* are much greater than those between it and *C. remissa*, which is effectively parapatric, being segregated only by the Columbia River and the spine of the Cascade Mountains. *Chonaphe remissa* replaces *C. armata* west of the Cascades in Washington, as the latter occurs only on their eastern slope, but in Oregon, *C. remissa* is absent, and *C. armata* occurs only west of the Cascades, in the lower Willamette Valley and eastern foothills of the Coast Range as far south as Benton County. *Chonaphe evexa* is thus an allopatric, southern species, detached from the main generic range by some 125 mi (200 km); *C. schizoterminalis*, in northeastern Washington, is essentially parapatric with a population of *C. armata*.

The picture at the generic level (Fig. 71) is identical to that at the specific, with the exception of *Selenocheir* in California and *Chonaphe* in Washington. *Selenocheir* covers a broad area in southwestern Oregon and northern California with a finger extending southward through the Sierra Nevada foothills. In *Chonaphe*, the ranges of *C. armata* in western Washington and Oregon join with that of *C. remissa* to form a large area with a finger extending southward down the eastern slope of the Coast Range and the western Willamette Valley. Ranges are also mutually exclusive except in Idaho and environs, where they overlap as in the species.

RELATIONSHIPS

Tribal—What seemed to be a straightforward study from such specialized genera as *Chonaphe* and *Semionellus*, with their apomorphic acicular acropodites and elaborate prefemoral processes, rapidly became complex as I pondered forms like *T. levii*, *Montaphe paraphoena*, and *Metaxycheir prolata*, and the meaning and significance of such inconsistencies as the presence of lateral versus medial sternal lobes, and the presence or absence of a sternum. Because the acropodites of its species are as narrowly blade-like or acicular as those of *T. levii* and *M. prolata*, the question arose as to whether *Selenocheir* is also a chonaphine, but with a short, instead of a long, prefemoral process. No other established tribe can accommodate *Selenocheir*, and a monobasic category would be undefinable, so I place it in the Chonaphini. *Selenocheir*

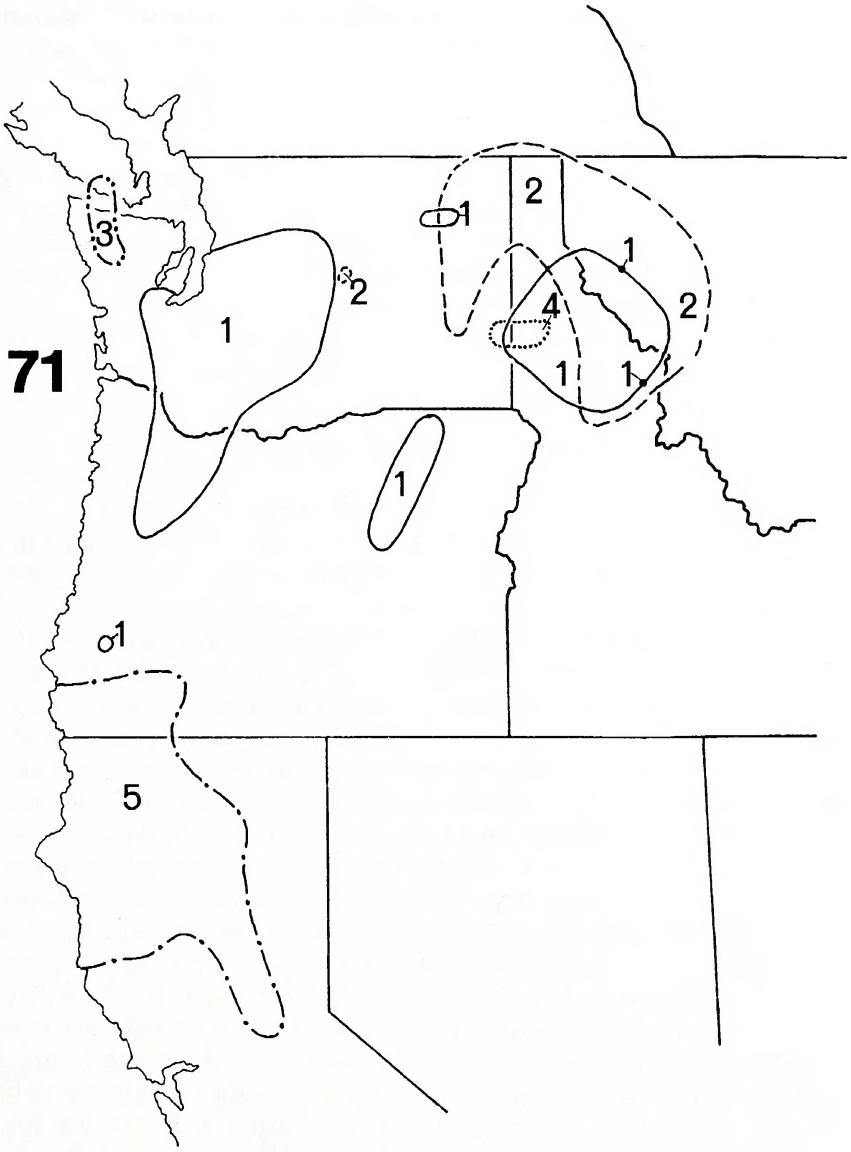


Fig. 71. Comparative distributions of chonaphine genera in western North America. 1, *Chonaphe*; 2, *Montaphe*; 3, *Tubaphe*; 4, *Metaxycheir*; 5, *Selenocheir*.

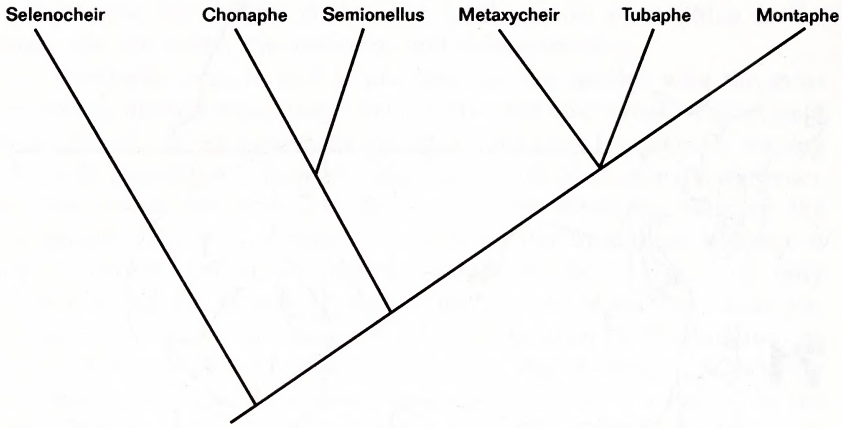


Figure 72. Relationships in the Chonaphini.

sinuata was previously misidentified as *Isaphe tersa* (Cook), a member of the Harpaphini (Causey 1955, Buckett 1964), because of key similarities between *Selenocheir*, particularly *S. directa*, and *Isaphe* (= *Hybaphe*). In *I. tersa*, as in all harpaphines, the coxa is larger than the telopodal elements in overall bulk, and the latter is oriented transversely on the prefemur so as to project directly mediad; the telopodal elements therefore extend directly toward the viewer in medial aspect, so as to provide a head-on perspective rather than a profile (Shelley 1993*d*). In *S. directa*, the coxa is proportionately the largest in the genus, being only slightly smaller than the telopodite, and the telopodal elements are directed anteromediad, or about midway between a head-on view, as in the Harpaphini, and a profile, as in chonaphine genera like *Tubaphe* and *Montaphe*. Consequently, *S. directa*, and to a lesser extent the entire genus *Selenocheir*, span the anatomical gaps between the Chonaphini and Harpaphini, and if future workers conclude that they should be merged, the former name holds priority. As the Asiatic representatives of the Harpaphini have not been reviewed, and their characteristics are poorly known in contrast to the American forms, I believe a decision on this potential merger should be deferred until the Oriental genera are better understood. Suffice it to say for now that the Chonaphini is closely related to the Harpaphini, and that the component taxa of both groups demonstrate a broad range of expressions of a suite of anatomical features.

Generic and Specific—Two obvious chonaphine lineages are apparent—one with expanded, laminate prefemoral processes and acicular acropodites (*Chonaphe* + *Semionellus*), and one in which the prefemoral process is narrow and blade-like, and the acropodite broader and less

acicular (*Montaphe* + *Tubaphe* + *Metaxycheir*). *Selenocheir*, with its short, plesiomorphic prefemoral process, represents a separate, sister line. There are no intermediate forms with partly expanded prefemoral processes or ones of intermediate lengths, an anatomical gap that suggests age and the extinction of intermediate forms. Age is also indicated by the substantial geographical gaps—between intraspecific populations of both *S. placidus* and *C. armata*, between species of *Chonaphe*, between *Metaxycheir* and *Tubaphe*, and most especially between the western faunal regions and *Semionellus*. *Chonaphe evexa* and *schizoterminalis* share an angular elevation on the dorsal face of the prefemoral process distal to the shield, this being a low ridge in the former and a laminate flap in the latter, and appear to be peripheral relicts of an early lineage that has been supplanted by the younger branch leading to *C. armata* and *remissa*, which possesses the thicker, distal projection at the location of the ridge. Although evolving more recently, the *C. armata* + *remissa* lineage is old enough to have undergone substantial fragmentation, with lacunae between the populations of *C. armata*.

Regarding the forms with narrow, blade-like prefemoral processes, the restricted distributions of *Metaxycheir prolata* and *T. levii* also suggest age, and the former in particular seems to hold relict status because it is known only from 4 samples and 6 adults despite inhabiting the most heavily sampled area of Idaho. *Montaphe elrodi*, occupying a broad, cohesive area in the western interior, evolved more recently, and *M. paraphoena*, an enigmatic species, is a possible relict from an intermediate line between the narrow, blade-like and expanded, laminate forms. I am unable to resolve the relationships between these genera and show an unresolved trichotomy in Figure 72.

My overall impression of the Chonaphini is thus one of age. The geographical and anatomical lacunae contrast markedly with the situations in the Eastern and Meso-American tribes Apheloriini, Nanariini, Pachydesmini, and Rhysodesmini, which lack such gaps and evolved more recently (Shelley and Whitehead 1986). The Chonaphini appears to be the second oldest xystodesmid assemblage next to the Orophini, which has an even larger geographical hiatus between its only nearctic representative, *Orophe*, in Idaho and Montana, and the only other known genera *Pamelaphe* and *Kiulinga*, in China (Hoffman 1964, Shelley 1993*e*). Perhaps the Xystodesmidae, or more properly the subfamily Xystodesminae, experimented at an early age with long, twisted gonopodal telopodites and ones with long, slender, comparatively simple acropodites and complex prefemoral processes, before settling

on the pattern of complex, elaborate acropodites and relatively short, simple prefemoral processes. The descendants of such early experimentations survive today in discontinuous ranges as the tribes Orophini and Chonaphini, respectively.

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ERRATA

In *Brimleyana* Number 19, page 51, the numbers 10 and 11 were inadvertently reversed in the caption to figure 32. Number 10 actually denotes *Scytonotus virginicus* intergrades, and number 11 is for *S. v. virginicus*. Numbers are correct on the figure.

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